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The Perceptions and Lived Experiences of Female Students in a Computer Science Program at a Community College

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This is to certify that the doctoral study by

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Walden University
2020

Abstract

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by

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MS, New Jersey Institute of Technology, 1991

BS, New Jersey Institute of Technology, 1983

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

America's higher education institutions have aligned computer science curricula with today's modern technology. Despite these efforts, data have shown that there is slow growth among young women majoring in computer science and even slower growth in this area at community colleges. Higher education institutions have also acknowledged a gap between men and women entering the computer science field and a need to explore options for computer science programs to engage women in the industry. The purpose of this phenomenological study was to gain an understanding of the perceptions and lived experiences of female students enrolled in computer classes at New Jersey Community College (pseudonym). Vygotsky's social constructivist theory formed the conceptual framework. The 4 research questions addressed female students' perceptions and lived experiences of their computer science classes, expectations for the courses, and whether these courses changed their views about computer science careers. Interviews with 7 female student participants were conducted to gather rich, detailed descriptions of their experiences; basic inductive analysis was used to examine collected data. This study's findings included (a) mentors and role models, (b) lack of gender diversity, (c) intimidation, and (d) the determination to succeed can be used to implement changes to computer science curricula and implement new programs. Implications for positive social change include the potential to increase women in the computer science industry. This research is significant for educators, administrators, and students in computer science programs.

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Dedication

This is dedicated to my husband, Robert Lewis Voldase, and my children, Christopher Marc Voldase, Chelsea Leigh Voldase, and Chase Lewis Voldase. They allowed me to miss important events so that I could devote myself to my educational journey towards this degree. In addition, I would like to thank my parents, Wilma Fields Knight and the late Marcellus Knight, who inspired me to continue my studies in obtaining a doctoral degree.

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Section 1: The Problem

This study concerns the perceptions and lived experiences of female students in computer science courses at a midsized community college in central New Jersey. Section 1 includes the definition of the problem that prompted this study at both the local and national levels, the purpose and rationale of the study, and the four guiding research questions (RQs). Social constructivism formed the conceptual framework of this study to understand the experiences of female students in computer science courses and to better comprehend their perspectives through their experiences (Lodico, Spaulding, & Voegtle, 2010).

The Local Problem

There is an underrepresentation of female students in the computer science program at New Jersey Community College (NJCC), a pseudonym, a 2-year public college in central New Jersey. Computer science courses at this institution and others have a disproportionately smaller number of female students as compared to male students. General education courses at the institution, such as computer literacy classes, may have a balanced enrollment of female and male students as they fulfill many of the technology electives. However, female students, compared to the overall student ratio at the institution, are still underrepresented in other computer science courses. The situation faced by NJCC is significant, as the school is striving to increase female enrollment in the computer science discipline; therefore, research is needed to better understand and address this problem.

The computer science department at NJCC has many degree programs for students to pursue. An Associate of Science is a degree designed to transfer to 4-year colleges and is offered in the fields of computer science, information systems and technology, and web developer. Other degree options include an Associate of Applied Science for students who will then go directly into the workforce or look to advance in their current profession. The Associate of Applied Science program includes degrees in computer networking, computer programming, game development, information systems and technology, and interactive digital media. Other options include certificate programs specialized for students looking to advance in their jobs or learn new skills.

Although there are many options for students to choose from in the math and computer science department, NJCC has experienced low female student enrollment in the computer science field as well as all technology and science disciplines. It is computer science programs, however, that have had the lowest percentage of female participation when compared to other programs in the science, technology, engineering, and mathematics (STEM) disciplines. According to NJCC, only 4% of students majoring in computer science are female. This study was designed to provide an understanding of the perceptions and lived experiences of female students regarding computer science courses and whether these can improve the experiences of females enrolled in these courses.

One of the most challenging problems confronting higher education locally and nationally is low female enrollment in computer science majors (Hardy & Montgomery, 2016). The National Science Board (NSB, 2018) concluded that computer science, in particular, faces challenges in diversity beyond the inclusion of women. In 2015, associate degrees in computer science earned by minority groups, including African Americans, Hispanics, Asian or Pacific Islanders, and American Indian or Alaska Natives, totaled 12,637 compared to 20,509 awarded to Caucasians (NSB, 2018). But the computer industry is the fastest-growing field in the United States and leads to one of the highest paying careers for college graduates (Adams, 2015). According to the National Association of Colleges and Employers (2020), computer science and engineering are the most likely STEM majors to receive high starting salaries. The U.S. Bureau of Labor Statistics (2020) predicts that computer science careers will continue to be one of the fastest growing sectors of the U.S. economy, with nearly 3.5 million job openings by 2028. Table 1 shows the number of projected computer science occupations available by 2028, and the level of education needed to fill these occupations. Graduates are highly sought after in information technology fields and include programmers, software developers, system analysts, web developers, information security analysts, database administrators, and computer network architects.

Table 1

Computer Science Occupations in Demand with Projected Job Openings from 2018 to 2028

Occupation	Number of jobs (2018)	Employment change (2018-2028)	Job outlook (2018-2028)	Median pay/yr. (2018)	Entry-level education 2018-(2028)
Computer hardware engineers	64,400	4,000	6%	$117,220	Bachelor's degree
Computer systems analysts	633,900	56,000	9%	$90,920	Bachelor's degree
Computer support specialists[a]	863,100	83,000	10%	$54,760	Some college
Information security analyst	112,300	35,500	32%	$99,730	Bachelor's degree
Software developers	1,365,500	284,100	21%	$107,510	Bachelor's Degree
Computer programmers	250,300	-17,900	-7%	$86,550	Bachelor's degree
Computer and IS managers	414,400	46,800	11%	$146,360	Bachelor's degree
Database administrators	116.900	10,500	9%	$93,750	Bachelor's degree
Web developers	160,500	20,900	13%	$73,760	Associate degree
Computer network architects	159,300	8,400	5%	$112,690	Bachelor's degree

Note. From *Occupational Outlook Handbook*, 2020, U.S. Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections, 2020. Retrieved from https://www.bls.gov/ooh

[a] Unless otherwise specified, occupations typically require neither work experience in a related occupation nor on-the-job training to obtain competency.

[b] In addition to the education specified, this occupation typically requires 5 years or more of work experience in a related occupation.

Though computer science encompasses most aspects of society and provides the basis for modern technology and innovation, a disproportionate number of women are not pursuing degrees in this field (Master, Cheryan, & Meltzoff, 2016). Opportunities for women with information technology (IT) skills exist, as IT departments are trying to diversify their workforce with talented females. For example, in 2019 the average starting salary in engineering and computer science for those holding a bachelor's degree was $77,300. By comparison, the average starting salary in business with a bachelor's degree was $58,299 (National Association of Colleges and Employers, 2020). The lack of women in computer science as well as other STEM disciplines is one of the largest areas of gender disparity in the United States, occurring in both higher education and in the workplace (Master et al., 2016). Young women are avid users of new technologies; however, they are significantly underrepresented as professionals in the computer industry (Master et al., 2016). Table 2 illustrates the percentage of women employed in select computing occupations from 2010 to 2019.

Table 2

Percentage of Women Employed in Computing Operations from 2010 to 2019

Computing occupations	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Operations research analysts	46%	45%	55%	52%	55%	51%	55%	52%	49%	43%
Database administrators	36%	37%	37%	37%	28%	38%	41%	41%	38%	30%
Computer support specialists	28%	26%	27%	29%	27%	26%	26%	27%	22%	26%
Computer scientists and systems analysts	31%	34%	31%	35%	34%	34%	36%	39%	38%	40%
Computer programmers	22%	21%	23%	23%	21%	21%	23%	21%	21%	20%
Network and computer systems administrators	17%	23%	25%	17%	19%	16%	17%	24%	21%	26%
Computer software engineers	21%	19%	20%	20%	20%	18%	20%	19%	19%	19%
Computer hardware engineers	10%	13%	15%	9%	15%	13%	25%	17%	19%	23%

Note. From *Occupational Outlook Handbook*, U.S. Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections, 2020. Retrieved from https://www.bls.gov/ooh

In 2010, President Obama promoted STEM initiatives aimed at increasing women as well as other underrepresented groups in STEM fields. The president's initiatives involved partnerships with corporations, universities, foundations, and nonprofit organizations to inspire students to excel in STEM subjects (The White House, 2010). The program appears to be effective in that female enrollment in STEM majors has begun to gradually increase at baccalaureate-granting institutions. However, since 2006, the number of women who have been awarded associate degrees in computer science has decreased by 1.4% (National Science Foundation, 2015). The low percentage of female students majoring in computer science is prevalent at institutions of higher education throughout the United States. In 2018, the NSB found there had been a significant decline in women in community colleges majoring in computer science. Female students earned 60% to 62% of all associate degrees between 2000 and 2015; however, women who earned these degrees in computer science declined from 42% in 2000 to 21% in 2015. (NSB, 2018). The number of associate degrees in computer science awarded to females is also considerably lower than associate degrees awarded to male students (NSB, 2018).

Rationale

The rationale for this study was to understand why a computer science program at a local community college continues to have low female student enrollment. Analysis of the data helped determine the factors behind this problem and may help bring about positive change by increasing female registration in computer science programs at NJCC and other higher education institutions. The purpose was to gain an understanding of the perceptions and lived experiences of female participants enrolled in computer science classes at NJCC regarding computer science as an area of study as well as their perceptions regarding future employment in the profession. A phenomenological research design was used to determine if computer science classes at NJCC changed the perceptions of the female college students to pursue a career in computer science. Outside factors, such as peer influence and lack of career awareness, were also included in identifying potential barriers to enrollment.

In my analysis of higher education institutions, I concentrated on the perceptions and lived experiences of female students in undergraduate computer science courses. Higher education policymakers are trying to address the shortcomings regarding women's underrepresentation in computer science and implications for these institutions and the profession. Colleges and universities throughout the United States continue to have significantly low enrollment of women and minorities in the technological and science disciplines. In reviewing several mission statements from higher education institutions, many included increased diversity as part of their college goals. However, many colleges and universities face increasing challenges in upholding their mission standards when it comes to undergraduate computer science programs. The scarcity of women in this field has a significant impact on these institutions and many are trying to increase female and minority enrollment in STEM programs by offering grants and scholarships sponsored by the National Science Foundation. It is important to understand why women are not enrolling in computer science courses and recommend strategies that can be implemented at community colleges to reverse this trend. Thus, the intent of the study was to better understand the female participants' perceptions and lived experiences of computer science and their impact and to identify why they chose (or did not choose) to pursue a career in this field.

Definition of Terms

The following terms are used throughout this study:

Computer science: The systematic study of algorithmic processes—the study of feasibility, structure, expression, and mechanized processes (Boston University, 2003). Job opportunities include designing and building software, solving computing problems, developing new approaches, and using computers to meet new challenges through robotics, computer vision, and digital forensics (Association for Computing Machinery, 2013).

Computer scientist: A person who specializes in the theory of computation and the design of computational systems and new technology. A person in this profession designs computers and software through theoretical expertise and practical applications and uses technology to solve problems, create applications, develop websites, or program software (U.S. Bureau of Labor Statistics, 2020).

Information technology (IT): A form of technology that uses of hardware, software, and services to manage and deliver information with voice, data, and video (Khan, 2013).

Science, technology, engineering, and mathematics (STEM): Includes the fields of science, technology, engineering, and mathematics. Employment includes both professional and technical support positions in computer science, engineering, mathematics, and the physical sciences (Beede et al., 2011).

Significance of the Study

An examination of published peer-reviewed literature revealed that colleges and universities have experienced substantial growth in female enrollment, especially in community colleges. In 2016, women made up 56.4% of student enrollment at community colleges (American Association of Community Colleges, 2019), but despite this growth, female enrollment is still lacking in computer science majors. Data from the NSB (2018) revealed that in America's community colleges, the percentage of female students who earned associate degrees in computer science declined in 2015 to 21% from 42% in 2000. The data also showed a disparity between men and women who pursued bachelor's degrees in computer science, engineering, mathematics, statistics, and physics from 2002 through 2015 (NSB, 2018). In addition, female graduates who earned bachelor's and graduate degrees in computer science were more likely to have attended community colleges than their male counterparts, indicating that community college STEM programs are an important pathway to advanced degrees for female students (Lyon & Denner, 2016).

Researchers have suggested that stereotypes regarding computer science may have kept female students from pursuing a degree in this field. Misconceptions may lead to labeling or name calling with students being termed *geeks* or *nerds* (Del Toro, 2019). Although these images are not specifically assigned to male or female students, women view these careers more negatively and perceive computer scientists as having traits unrelated to being female (Cheryan, Plaut, Handron, & Hudson, 2013). Computer scientists have also been perceived as lacking interpersonal skills and fitting the stereotype of someone who is only focused on computers rather than people (Cheryan et al., 2013). These stereotypes have been attributed to three factors:

- parental influences on the distinction of male and female roles in society (Harackiewicz, Rozek, Hulleman, & Hyde, 2012),
- lack of female teachers and mentors in STEM courses (Beilock, Gunderson, Ramirez, & Levine, 2010), and
- differential treatment of female students by faculty and peers (Cheryan, Siy, Vichayapai, Drury, & Kim, 2011; Ong, Wright, Espinosa, & Orfield, 2011; Paluck, 2010).

A phenomenological study was conducted to develop a better understanding of female college students' perceptions and lived experiences in computer science courses at NJCC. Data from this study were collected and examined regarding the participants' perceptions of their involvement in these courses and to help identify any underlying causes for the lack of participation in the computer science field. The underrepresentation of female students is important as the U.S. Bureau of Labor Statistics (2020) predicts that IT careers will continue to be one of the fastest growing sectors of the U.S. economy (see Table 2). Results from this study provide direction to effect change to improve the perceptions of female students in computer science at NJCC and other higher education institutions.

This study builds on past research regarding female computer science majors by exploring the participants' perceptions during their 2 years at NJCC, a midsized community college in central New Jersey. No studies have been previously conducted at this institution. The results of this project will help inform the community college regarding female students' perceptions and lived experiences in computer science classes. The findings also include recommendations to support female students in their decision to enroll and remain in this major as well attract others into computer science careers. Furthermore, the awareness gained from this study serves as a guide to develop interventions and other changes that encourage more female students to pursue the computer science profession. Findings from the study could also be used address the national underrepresentation of women in computer science through the implementation and adaption of curricula and other programs to meet their needs.

Research Questions

Four RQs were developed to guide this study to gain a better understanding of how female students perceived the computer science program at a community college. The RQs helped steer the data collection and analysis process regarding the perceptions and lived experiences of the participants.

RQ 1: What are the perceptions of female students regarding their image of professionals in computer science fields?

RQ 2: What are the perceptions of female students on the content of computer science courses at NJCC in that they are found to be supportive or not supportive of their continued participation in computer science courses?

RQ 3: What computer science classes do female students find attractive that could lead them towards a career in computer science and their reasons for perceiving these courses from that perspective?

RQ 4: In what ways does the content of computer science classes change female students' views towards the completion of a computer science degree?

Review of the Literature

To fully understand the perceptions and lived experiences of female students in computer science courses at a community college, I examined the peer-reviewed literature on gender diversity in computer science and computer science courses relevant to this study. In my analysis of higher education institutions, I concentrated on the perceptions and lived experiences of female students in undergraduate computer science courses. The review includes the history of women in computer science, cultural differences, gender differences, myths and stereotypes, female students' perspectives on computer science, and early nonacademic speculation on the problem. I address elements that may have influenced the perceptions of female students in computer science courses at NJCC.

Conceptual Framework

Social constructivism theory was used as the conceptual framework in this project study (Vygotsky, 1978). To understand the experiences of female students in computer science majors, social constructivism provides a foundation to capture the participants' perspectives through their own experiences (Lodico et al., 2010). Lodico et al. (2010) and Lincoln and Guba (1985) viewed social constructivism as understanding complex realities from the perspectives of participants. A researcher conducting a study must become involved with the reality of the participants and view the world through their eyes (Lodico et al., 2010).

Piaget (1952), who suggested that humans must construct their own knowledge and that they build knowledge through their experiences, founded the theory of social constructivism based on cognitive development. Vygotsky (1978) rejected Piaget's assumption that it was possible to separate learning from its social context. Vygotsky's theory of cognitive development emphasized the influence of cultural and social contexts in learning and that cognitive development stemmed from social interactions. In other words, the environment in which children grow up influences how they think and what they think about. Social constructivism theory has been used to study computer science education with stereotypes and the classroom environment at the forefront of the findings regarding gender disparity (Ben-Ari, 2001; Berg & Lie, 1995), thus validating cultural and social contexts in learning environments.

Review of the Broader Problem

I examined current research to help better understand the perceptions and lived experiences of female students in computer science courses at a community college. The research addressed elements that may have affected the perceptions of female students in computer science courses at NJCC. The search was conducted by focusing on the local and national problems of low female student enrollment and a search for materials demonstrating the root causes of the disparity women face in computer science programs in higher education and their long-term careers.

The information discussed the literature review is from primary sources found in the Walden University Library databases, higher education online library database at my employment, and Google Scholar. These included the Computer Science Database, ProQuest, EbscoHost, Academic Search Premier, JSTOR, and other sources related to the research topic. Keywords used in the searches included *stereotypes*, *biases*, *computer science*, *diversity*, *gender*, *gender-biases*, *intimidation*, *mentors*, *role models*, *perceptions*, *self-efficacy*, and *STEM*.

History of women in computer science. Women in working in science did not appear until the late 19th and early 20th centuries (Kahn & Ginther, 2017). This was apparent in 1927 when Marie Curie, who was awarded the Nobel Prize for physics in 1903 and for chemistry in 1911, was the only female scientist at the Fifth Solvay Conference on electrons and photons (Del Toro, 2019; James, 2013). But in the 1950s, computer science careers were saturated with female programmers (Cohen, 2016). Because there were no academic computing disciplines during that era, the number of women in computing fields could not be categorized strictly as computer science. However, women began to enter this workforce in America as early as the 1960s (Stevenson, 2020). Prominent women like Ada Lovelace and Grace Hopper were among the first female computer scientists to lead successful research teams in developing computer programming languages (Lambert, 2015). Grace Hopper was known as the first female programmer. In 1946, she was part of the team that developed the first electronic digital computer, known as the Electronic Numerical Integrator and Computer (Cohen, 2016).

Since this time, women have been well represented in the programming profession through the mid-1980s. Before the 1960s, computer programming jobs were considered clerical jobs and women were hired to input data into preset work (Cohen, 2016). However, the responsibilities of programming became less mechanical and as a result, men were being recruited to fill computer programmer and scientist positions (Kane, 2011). According to Kane (2011), these men were known as the "computer boys," hired as computer programmers with math and engineering backgrounds, demonstrating stereotypical masculine qualities. According to the U.S. Bureau of Labor Statistics (2017), women will account for 47.2% of the workforce in 2024 with the gap between female and male employees decreasing by 5.6%.

Gender differences in computer science. Many theorists have attributed gender differences as a factor that has kept female students from entering computer science programs. Females are often told that they will not succeed in STEM careers. Social norms have dictated male and female behaviors and attributes, including their choice of careers (Trauth, 2006). Other studies have suggested that women's personalities were different from men and they may not have the correct skill sets for technical studies (Pinker, 2002). Research has also focused on biological differences between the male and female brains, suggesting that they were connected differently and that women are more empathetic, whereas men are equipped for constructing systems (Baron-Cohen, 2003; Trauth, 2006).

The conclusions of older research studies that genetic differences between men and women had any impact on their abilities in computer science are now being challenged (Dubow & James-Hawkins, 2016). The lack of participation by women in the computer science field can be attributed to the perception that it was a masculine subject, deterring them from pursuing it as a career. The real issue is not the biological differences of the sexes but rather how women fit into the computer science field. Changes in culture and a balanced academic environment would allow women to fit in the computer science field academically. But most women have preferred not to study computer science, resulting in gender disparity in technical careers (Dubow & James-Hawkins, 2016).

Despite the gender disparity in computer science, those with positive experiences have had better achievement in computer science. In a study on the self-identities, aspirations, and personal experiences of female STEM undergraduate students, participants had positive perceptions of females in STEM and that their university had a welcoming environment (Moyers, 2016). Those with positive perceptions not only have high self-efficacy but high aspirations for themselves (Miller & Wai, 2015). Additionally, Berdousis and Kordaki (2015) indicated that though male students had better grades in the required courses for both divisions, female students achieved better grades in noncore programming courses, such as Hardware Description Languages IT, Introduction to Embedded Systems, Digital Circuit Design, and Computer Organization. It was also noted that female students earned higher grades than their male counterparts when they were in the majority in the course (Berdousis & Kordaki, 2015). Further, Ioannis and Kordaki (2019) found that male students preferred courses related to software and hardware engineering, while female students preferred courses related to theoretical computer science as well as the social and human aspects of computer science. However, there were not find any significant differences in terms of gender performance.

Myths and stereotypes about computer science. Stereotypes in the computer science industry regarding who should be performing these jobs are still perpetuated, even into this century (Shein, 2018). Myths and stereotypes about male and female gender roles begin as early as elementary school, with young girls associating boys with mathematics and computer science and associating themselves with more nurturing roles like teachers and childcare providers or practical roles like doctors and lawyers (Hur, Andrzejewski, & Marghitu, 2017). According to Main and Schimpf (2017), boys during their early years have a strong interest in computer games, but girls are interested in television during leisure activities, communicating over social media, listening to music and watching television, demonstrating boys' interest in computer science than girls. Additionally, young girls' perceptions regarding computer science careers indicate that those who pursued these careers had to be brilliant, unwilling to be a part of a team, and work independently in an isolated environment (Leslie, Cimpian, Meyer, & Freeland, 2015). Although myths about gender differences concerning ability and intelligence are not real in the scientific sense, they are real in terms of social implications and have an everlasting impact on female success (Alkhadrawi, 2015).

High school and middle school girls also have a different perspective about computer science than high school and middle school boys and its stereotypical images as demonstrated by the media and other social outlets. Preconceived notions concerning computer scientists have been perpetuated throughout high schools; they are often thought of as geeky, socially awkward, intelligent males who are focused on technology (Cheryan, Master, & Meltzoff, 2015). Most high school girls avoid any type of computer programming courses, and those who do decide to take computer science courses are less likely to take the Advancement Placement Computer Science Exam (Alba, 2017).

Although the percentage of girls who took the exam increased from 18% in 2007 to 27% in 2017, it still demonstrates that only one quarter of female students took the exam compared to male students in computer science courses (Alba, 2017). Further, by the time they enter college, males are more likely to major in computer science and engineering than females (National Science Foundation, 2015). For female students, the less sense of belonging they feel regarding the computer science field, the less they will likely pursue a degree or career in that field (Master et al., 2016). Taking steps to change misperceptions about computer science for females will increase their involvement in computer science and other STEM fields dominated by men (Master et al., 2016).

Research has shown that visual representation of computer science and scientists is important for female perceptions of computer science. For instance, Master et al. (2016) found that classroom design was important to female students. Sixty-eight percent of the girls in the study preferred a classroom with art and nature pictures rather than computer parts and *Star Wars* posters. The findings indicated that more high school girls would enroll in computer science courses if they were in nonstereotypical classroom environments. A sense of belonging is what drives female students in masculine-type careers, and educators should be cognizant when designing classroom environments to increase female students' enrollment in STEM fields while not alienating male students (Master et al., 2016). Additionally, Banchefsky, Westfall, Park, and Judd (2016) showed eighty photos of STEM faculty, 40 females and 40 males, throughout universities in the United States. Participants aligned gender appearances with the likelihood of being a scientist for females as opposed to males. Thus, females in STEM aptitude in their careers or sense of belonging could have a negative affect them due to their feminine appearance (Banchefsky et al., 2016).

The media is also influential in its messaging and can help pave the way for diversity computer science and other STEM fields. Cheryan et al. (2013) suggested that when the media reported nonstereotypical images of computer scientists, female students were more likely to consider majoring in this field than women who read articles that included these stereotypes. Additionally, television sitcoms such as *The Big Bang Theory* portrayed male actors as stereotypical computer scientists; however, since 2010, female scientists in STEM careers emerged on the sitcom, exposing the realities encountered by females. Presently, the media is trying to change the images and stereotypes of computer science. Internet shows such as the PBS series *SciGirls*, *Dot Diva*, and *Picture Me in Computing* have expanded the images of computer science and female gender roles by showing women solving problems in everyday life (Cheryan et al., 2013).

Overall, stereotypes have affected females' career aspirations (Schuster & Martiny, 2017). In a study on stereotype-activating signals, undergraduate female students were asked to read and visualize a scenario for participating in an attractive job (Schuster & Martiny, 2017). In the stereotype scenario, a male employer asked females to demonstrate their mathematical skills by solving a geometrical problem to an all-male group of competitors, singling them out by having them go first. In the non-stereotype scenario, a female employer asked them to prove their stress resistance by explaining a solution of the same problem to a mixed gender audience of competitors, and any gender could go first. Results indicated that female participants felt good in a non-stereotype scenario than a stereotype scenario (Schuster & Martiny, 2017). In another study, Schuster and Martiny (2017) administered a test of both math and problem-solving abilities with no remarks about specific gender. Schuster and Martiny concluded that when female students are underrepresented in STEM, they may anticipate having more negative feelings toward that particular career. Both studies suggested that nonstereotype contexts might change females' attitudes over time in STEM careers.

Female students' perspectives on computer science. In addition to cultural differences and myths about the stereotypical roles of computer scientists that have contributed to the decline of female students enrolling in computer science programs, researchers have studied female students' perspectives about computer science programs. From early adolescence, females have expressed less interest in STEM careers than their male counterparts, and studies have shown an overall decrease in the number of young females participating in computer science courses (Main & Schimpf, 2017). Even women who excel in mathematics often do not pursue STEM fields. Women are more likely to obtain degrees in the social sciences, humanities, and life sciences than in STEM degree programs like mathematics, computer science, engineering, or physical sciences (NSB, 2018). Academic preparedness and the desire to pursue STEM disciplines are the two primary factors for women when choosing STEM majors (Cutler, 2012). Sociocultural factors also have a strong influence over career decisions, which could impact the choices women make regarding STEM career paths (Wang & Degol, 2017).

Effective mentoring for female students is essential for helping women progress in STEM fields. Role models are needed to lay the foundation for potential female students and should encourage them to pursue a field that contributes to solving global problems (Cutler, 2012). Positive role models are instrumental in female interest in computer science (Galvin, 2016). Female teachers also play a key role in influencing female students in computer science in middle school, high school, and higher education institutions (Galvin, 2016). Further, females do not have career longevity in computer fields due to lack of role models and mentors (Cheryan, Ziegler, Montoya, & Jiang, 2017; Stevenson, 2019). Highly talented women are leaving computer science fields because of negativity and obstacles such as isolation, intimidation, and overt biases (Dawson, Bernstein, & Bekki, 2015). Females are less likely to achieve in environments where gender stereotypes are prevalent within male-dominated environments (Cheryan et al., 2017).

Additionally, many have changed majors due to lack of interest, as these programs were seemingly geared toward men (Gose, 2012). Researchers like Gose (2012) suggested overhauling higher education's introductory computer science courses to include curricula directed at women to create better experiences for them. For instance, the University of California, Berkeley and its course, Beauty and Joy of Computing, featured real-world applications in the computer science field. This type of remaking of computer science courses has led to increased enrollment of women at some colleges and universities including University of California, Berkeley (Brown, 2014). The modernization of the curricula will increase female enrollment and faculty would create a better overall experience for female students.

Denner, Werner, O'Connor, and Glassman (2014) conducted a longitudinal quantitative study to examine beliefs on how to increase the number of computer information systems (CIS) majors, particularly females, at 4-year universities. Findings from their study, which included 741 male and female students from 15 community colleges in California enrolled in an introductory programming class, highlighted two important factors regarding why female students have lower intentions to pursue computer science. Female students reported significantly less encouragement from peers to pursue computer science than did their male counterparts. The results also indicated that male students frequently interacted more with their computer science professors than did female students (Denner et al., 2014)

According to Starobin, Jackson Smith, and Laanan (2016), community colleges are the primary resource for females interested in STEM programs. Starobin et al. conducted a qualitative study exploring the experiences of female students in STEM. Findings from their research revealed the importance of having positive student-faculty interactions and classroom environments, which influences females' abilities to perform successfully in their majors. Another study performed by Jorstad, Starobin, Chen, and Kollasch (2017) examined the factors of female community college students transferring into STEM majors. These factors included student engagement, social capital, and an unwelcoming climate. The study demonstrated that more research is needed to assist female students in their endeavors in STEM degrees (Jorstad et al., 2017).

Hodges and Corley (2017) conducted a quantitative study to determine whether past research studies on beliefs, images, and job accessibility influenced women's decisions regarding their academic selections. The researchers used a survey created by Zhang (as cited in Hodges & Corley, 2017), who used it to collect data to determine what factors influenced female participation in CIS. Hodges and Corley used the same survey to ascertain if these same factors apply today. The results showed similar findings when it came to job availability and difficulty of curriculum. However, there were significant differences when it came to personal images in CIS. Zhang's study (as cited in Hodges & Corley, 2017) revealed that females perceived the image of a CIS major to be geeky or nerdy. Hodges and Corley's study revealed that females are embracing technology and careers in CIS are acceptable choices for them.

Clinkenbeard (2017) conducted a research study to determine the factors that influenced the success of male and female computer science college students. The findings indicated that computer self-efficacy, peer interactions, self-concept, comfort with computers, and achievement goals were the elements for attaining successful final grades. In the study, male students achieved higher levels of computer self-efficacy and self-concept as opposed to female students. Self-efficacy was the important factor for success for female students in computer science. Clinkenbeard concluded that comfort and a sense of belonging in computer science can lead to achievement for female students following this career path.

Google (2014) conducted a study to explore the factors that influence women to pursue a degree in computer science. According to the study, there were four major areas that that affected this pursuit: (a) social encouragement, (b) self-perception, (c) academic exposure, and (d) career perception. Google's findings indicated that social encouragement and academic exposure to computer science were the leading factors influencing female decisions to pursue a degree in computer science.

Buzzetto-More, Ukoha, and Rustagi (2010) examined the cause and effect of underrepresented women and minorities in undergraduate computer science and information systems programs at two Historically Black Universities in Maryland. The findings demonstrated that both women and minorities had not been advised by high school counselors to pursue undergraduate computer science degrees. Based on these findings, Buzzetto-More et al. recommended the following:

- There needs to be collaboration between colleges and high schools in recruiting minorities and women in undergraduate computer science programs.
- Preparatory courses should be offered for first-year students entering college,
- Scholarships opportunities should be offered for those students pursuing undergraduate computer science degrees.
- Support needs to be provided for those students needing additional assistance (academic or financial) to pursue a computer science discipline.

Buzzetto-More et al. took a practical approach in ensuring that women and minority students were given equal opportunities in succeeding in the computer science discipline. Although the findings from the study revealed disparities among minorities and computer science, other studies demonstrated enrollment disparities across gender and ethnicity.

Ashford (2016) conducted research to determine whether there were gaps in enrollment in computer science for female students at Historically Black Colleges and

Universities. Ashford researched African American women and found that there was no gap or decline in enrollment between African American women and men in computer science in these institutions. Ashford attributed this to the positive influences Historically Black Colleges and Universities have with African American women in obtaining computer science degrees. Smaller class sizes as well as supportive and nurturing environments were factors for African American women in achieving success in computer education and other STEM programs.

Early nonacademic speculation on the problem. Several studies have been conducted to understand the stereotypes associated with computer science and the reasons why female students are not majoring in this field. Some institutions have even implemented changes to their computer science programs to increase female student enrollment by making them “female-friendly” (Anft, 2017). However, Anft (2017) reported that although men and women embrace computer science studies and careers differently, some institutions have created gender parity in their computer science programs. According to Anft (2017), some institutions have a higher percentage of female enrollment in computer science because they eliminate any advantages male students may have in computing by providing female students and provided them with the same support systems. Blum (as cited in Anft) stated that women and minorities need to be provided with the same support systems that are given to men. "Many girls didn’t grow up with a computer, much less pull one apart, because their parents thought it was too dangerous. Meanwhile, the boys had had them since they were 5 and had been ripping parts out of them since they were teens" (p. 4). Findings in other studies have shown that changes made to course curricula, so are directed to both men and women, eliminated stereotypical and myopic views of computer science.

Frieze, Quesenberry, Kemp, and Velázquez (2012) examined the attitudes of computer science majors at Carnegie Mellon University. Frieze et al. disputed Ratliff (2005) and Trauth (2006), who suggested that biological differences between sexes contributed to female decisions about studying computer science. Both Ratliff and Trauth based their studies on an earlier assertions by Marini (1990), who assumed that differences between sexes in this area were biologically determined. Trauth concluded that the causes of gender underrepresentation in IT were biological by observing the differences in men's and women's characteristics. Frieze et al, however, indicated that there was no evidence of a strong gender divide in students' attitudes. In fact, in the computer science environment at the university, there was a strong fit both socially and academically for both genders.

Frieze and Quesenberry (2019) continued to examine the increase in female enrollment at Carnegie Mellon University. However, they took a cultural approach rather than gender differences approach. In their case study, the researchers reported that a change in culture and environment at the university increased female enrollment by 50%. The researchers also noted that curriculum changes to suit female interests could even deter females from pursuing computer science careers. According to Freize and Quesenberry, addressing the underlying culture of attitude, when it comes to gender, is vital to institutions in the United States, especially because cultures in other countries do not have an underrepresentation of female students in computer science. Freize and

Quesenberry suggested that institutions should focus on the specific attributes, including leadership, visibility, networking, mentoring, and advocacy, that Carnegie Mellon University put in place to increase female enrollment in computer science. Once female students develop a sense of belonging and are treated equally to their male counterparts, then institutions may experience an increase in female enrollment in computer science, over time, similar to Carnegie Mellon University.

Sassler, Michelmore, and Smith (2017) examined the gender gap between females and males employed in STEM career fields after graduating with bachelor's degrees in computer science and engineering. According to Sassler et al., female graduates are 14% less likely to work in computer science fields than male graduates. Their research broke down ethnicity and racial percentages in terms of females and males in both engineering and computer science. There were significant gender and racial gaps in both degree holders, but higher in computer science (Sassler et al., 2017). Women were less likely to work in computer science fields than women in engineering. Sassler et al. study suggested that there were some underlying characteristics between men and women in computer science fields as opposed to engineering fields. As reported by Master et al. (2016), Sassler et al. suggested that computer science careers were less unwelcoming than engineering towards women and that additional research is needed to address gender barriers in computer science.

In 2015, Tracey Lien, a journalist from the Los Angeles Times, interviewed several women who left their tech industries prematurely due to workplace bias. Lien interviewed distinguished law professor, Joan Williams from the University of California

Hastings, and Anna Redman, who teaches computer science at the University of Washington. Williams, Phillips, and Hall (2014) conducted a study on the experiences of women gender bias against women in STEM. According to Williams et al., one out of three women surveyed from 550 women in STEM careers reported sexual harassment. Williams et al., documented four distinct patterns of gender bias: (1) prove-it-again – women have to prove themselves over and over again, (2) the tight rope – in tech jobs, women have to behave in masculine qualities in order to been seen as competent yet they need to be seen as feminine, (3) the maternal wall – gender bias triggered by motherhood, and (4) tug of war – gender bias against women fuel conflict and women start distancing themselves from other women (Williams et al., 2014). Redman worked in the technology industry for 15 years as a software developer and left the industry in 2012. Redman discussed how she was asked to prove herself repeatedly and was always given entry-level responsibilities at her workplace. Redman's biases at her workplace forced her to leave the tech industry. To overcome biases in the workplace, Williams recommended that companies introduce bias interrupters to resolve cultural problems. These bias interrupters are changes to business systems such as hiring, performance evaluation, and assignments and evaluate whether object metrics have improved through assessments. Williams concluded the interview expressing that diversity need to be addressed this way to overcome biases in tech industries.

Based on a *Harvard Business Review* study in 2008, 50% of women in tech industries left their employment due to hostile work environments. Workplace bias continues to be the main reason women in technology fields leave the workplace.

Unconscious workplace biases, such as when women receive less pay than men, or hold jobs that have lesser perceived value, as well as experiencing negative behavior directed toward them, have caused women in technology positions to leave at a 45% higher rate than men (Ryoo, 2017). Women exiting the workforce will leave the industry with technology jobs that need to be filled by professionally qualified candidates. Women in computing positions are expected to decrease from 24% to 22% over the next 10 years (Wallace, 2016). Although companies such as Google, Facebook, and Apple are trying to eliminate gender disparities, higher education institutions need to work to attract female students to major in computer science programs.

Women in computer science programs at higher educational institutions are underrepresented. Factors that are responsible for this lack vary based on the research studies and analyses performed; however, many studies addressed cultural differences and society’s perception of women in male- dominated environments. The articles are similar in their findings in that there continues to be low enrollment for women in the computer science discipline. If there are not enough females to enter this career field, employers will not be able to fill these positions, which are critical to the economic needs of United States businesses (Saujani & Sweet, 2016).

Implications

To understand the effects of the decline and the underrepresentation of female students in computer science programs, a qualitative research study was conducted. A phenomenological research approach was used to focus on female students’ perceptions and lived experiences of computer science classes, curricula, and the workforce and how these perceptions can change female students’ views towards the completion of a computer science degree. Results of this study could lead to a better awareness of gender inequality of women in computer science careers, specifically, unequal treatment or perceptions due to gender.

Based on the data collected and analyzed in this research study, I will present recommendations for effective solutions to help clarify and improve the experiences of female students in computer science programs. Offering professional development workshops, educating secondary and higher education administrators and faculty on my recommendations based on the findings from this study will help raise awareness of female students’ experiences in computer science programs. The rationale for this study is to understand the perceptions and lived experiences of female students, which may help me to implement positive solutions that will increase female enrollment in computer science, and these recommendations can assist in achieving gender equality in computer science programs.

Summary

In Section 1, I presented an introduction to the study, including the problems at both the local and national levels, the purpose of the study, the RQs, and the conceptual framework. I also reviewed the literature relevant to this study, and discussed the implications of the study. The purpose of this study was to gain an understanding of the perceptions and lived experiences of female students enrolled in computer classes at a community college regarding computer science as an area of study as well as future employment in this profession.

In Section 2, I describe the methodology used in this study, including the research design and approach. I discuss the participant selection process and the relationship between myself, the researcher, and the participants, as well as the research site. Procedures for data collection and analysis are outlined, and the measures for ethical protection for the participants is also provided. In Section 3, I discuss the rationale for this project and provide a thorough review of the literature, a description of the project, and evaluation plan. Lastly, I explain implications of this project for positive social change. Section 4 is a discussion of the project's strengths and limitations and recommendations for alternative approaches. I provide an analysis of scholarship, project development, and leadership and change. I also reflect on the importance of the work, its implications, applications, and directions for future research.

Section 2: The Methodology

Qualitative Research Design and Approach

The research design for this project was phenomenology. The phenomenon studied was the perceptions and lived experiences of female students at NJCC who were enrolled in computer science courses regarding computer science as an area of study as well as a profession for future employment. One-on-one interviews with seven participants were used to collect the data. This approach was appropriate to gain an in-depth understanding of how female students in computer science courses at a community college perceived their experiences in a major that has a higher percentage of male students.

A phenomenological approach was best suited to explore the participants' perceptions and lived experiences (Creswell, 2012). This type of study allowed the participants to articulate their experiences and provide descriptions, sharing their stories (Hatch, 2002). Throughout the study, I put aside any biases or assumptions so that I was able to objectively collect data from the participants (Creswell, 2012).

Other qualitative designs were not suited for this type of research. A case study approach was not appropriate for this study as it requires multiple sources that include not only interviews but also questionnaires or other documents. Case study often uses multiple types of data, both qualitative and quantitative (Lodico et al., 2010). Ethnography was also not suitable, as this study typically occurs within the participants' environment and is often used to observe a particular cultural group. Finally, grounded theory research uses new data to explore a particular culture or activity and compare it with the existing data, forming a new theory that explains the process (Creswell, 2012).

Further, a quantitative study was not appropriate because it is used in experiments, polls, questionnaires, and surveys. Quantitative surveys may be used to collect large amounts of data; however, this method would not allow the participants to share their perceptions and experiences concerning computer science. Data derived from a quantitative study would not provide information necessary to identify common themes in the participants' responses or to recommend possible solutions to improve the perceptions and experiences of female students in computer science. However, quantitative research may be useful in follow-up studies to assess the effectiveness of any changes in NJCC's approach to attracting and retaining female students.

In contrast, a phenomenological design facilitated data collection to help better understand the specific experiences of female participants' and their viewpoints as well as exploring the meanings of those experiences. Phenomenology offered the systematic and logical approach necessary to provide essential explanations of a person's experience (Moustakas, 1994). The main purpose of the study was to determine what solutions can be implemented to assist female students with their perceptions and lived experiences in computer science courses. The continuous decrease in females in computer science careers justified the need for further research. This phenomenological study adds data to the body of research and may assist in developing computer science curricula, providing faculty mentors, and creating a classroom environment conducive to female student success.

In this study, one-on-one, semistructured interviews were used to collect data to understand female students' perceptions and experiences in computer science programs. To protect the confidentiality of the participants, a number generator was used when referring to the participants in the study preceded by the letters CS (computer science). Findings from this study help provide the foundation necessary to develop supportive recommendations for female students in computer science courses at NJCC (see Appendix A).

Participants

A purposeful sampling method was used to select the participants, which allowed me to select the participants based on specific criteria. Participants must have been female, 18 years of age or older, currently attending or an alumnus at NJCC, and enrolled or had been enrolled in one or more computer science courses. The participants also must have been seeking or sought an associate degree in a computer science program at NJCC. Prior approval from the chairperson of the math and computer science department at NJCC was acquired to gain access to participants.

To establish a research–participant relationship with the interviewees, I contacted the participants through e-mail to introduce myself and explain the purpose of the study. Meeting dates and times were established by e-mail for participants who were willing and eligible to participate in the interviews; participation was voluntary. For phenomenological studies, research recommends 5–25 participants (Creswell, 2012). The sample size for the study was seven female students, which was enough to reach data saturation (Creswell, 2012), meaning I was able to obtain enough data from the participants to answer my RQs. A small number of rich interviews are just as importance of having dozens of shorter interviews (Fusch & Ness, 2015).

Interview Setting

Student interviews were conducted in an administrative conference room on the NJCC campus. The room was free from distractions and located in a private area of the campus to minimize interruptions. A climate of mutual respect existed throughout the interview process, which established a positive working relationship between me and the participants. Interview data were collected using digital audio recording equipment with the permission of the participants to ensure the information from the interviews was accurate and complete. I also took notes during each interview, and I logged any details in a reflective journal of how I may have influenced the participants' responses in each interview, which helped me avoid biases or preconceived notions that could have negatively influenced the findings. The participants dedicated 60 minutes for the interview sessions.

Ethical Procedures

To conduct the study at NJCC, I completed the standard application for research ethics review by Walden University's Institutional Review Board (IRB) requesting approval to conduct research. To ensure that there was ethical consideration for the protection of the participants' confidentiality, Walden's IRB verified that I had planned to use all appropriate procedures (approval no. 02-15-19-0458674). I also submitted my research proposal to the IRB at NJCC for approval. Once Walden and NJCC approved the research proposal, I obtained a list of potential participants, contacted them via email, and obtained written consent prior to conducting the study. These approval procedures assured that the study followed all ethical guidelines (Lodico et al., 2010).

To protect the participants in the study, I did not use their names. Instead, I used a number generator, ascribing these numbers to each participant in the study. This ensured that their identity was not compromised. All confidential information throughout this study was handled using these identifiers throughout the interview and data analysis process. I took notes and audio recorded the participants with their permission to avoid any errors and utilized member checking in the data analysis. I provided all participants with transcripts of their interviews for their review. Prior to conducting the interviews, the participants were also made aware that if they wanted to withdraw from the interview process at any time, they were permitted to do so without any consequences, and any data collected would be destroyed immediately to ensure confidentiality.

Data Collection

Data were collected through face-to-face, semistructured interviews. To ensure the data were captured accurately, the interviews were audio-recorded. Before data collection, each participant was asked to read and sign an informed consent form, demonstrating that they understood the data collection process; afterward, they returned the form to me.

One-on-one, semistructured interviews were used to elicit and record the perspectives and lived experiences of the participants regarding computer sciences courses at NJCC, as a semistructured interview process is used in qualitative research studies (Merriam, 2009). Using semistructured interviews provided flexibility in the wording of the questions, allowed the participants to elaborate freely during the interview process, and enabled me to inquire further into their responses with follow-up questions. The largest part of the interview was guided by a list of prepared questions. This format permitted the participants to discuss topics in detail and allowed me to prompt the participants for more information to answer the questions.

To keep track of data and emerging themes, I used a system for storing and labeling the interviews and cataloged all documents. I added an identification code to each interview, creating a system of ordering. Transcription software was used to transcribe data for the study. The participants checked the data for accuracy after receiving their interview transcripts.

The results from this study were limited to the institution, NJCC, in which I conducted the study. The results of this study can serve as a catalyst for change at other institutions with similar challenges. It is important, however, to consider that the views of the participants may not reflect the views of other participants at similar 2-year institutions.

Data Analysis

I imported my data from Word into NVivo 12 Plus software prior to the coding process. NVivo software allowed me to code and capture specific patterns. Nvivo software allowed me to capture specific patterns from my data, which I was able to categorize and analyze. In this study, I followed the basic steps for analyzing data as described by Creswell (2012): organizing the data, coding the data, creating themes, and searching for connections across emergent themes. These steps help the researcher to interpret the findings and provide accuracy.

I began the data analysis by creating an Excel workbook that contained three spreadsheets. The first spreadsheet contained each of the RQs by columns and each of the participant's responses by rows. I assigned each of the participants' random numbers using a number generator starting with 101 and continuing through 107 to ensure confidentiality. This served as a visual process, which was useful to compare similarities and differences among the participants' responses and to establish patterns and themes. I read each of the responses from the transcripts and correlated them according to their relevance to each of the RQs. I used the random numbers that I assigned to each participant to identify them and ensure that their responses were correct. As I recorded the participants' responses that applied to each of the RQs, I implemented a notes column to capture any thoughts about the data. I divided each of the responses into common segments and transferred these into the second spreadsheet to begin coding the data.

The second spreadsheet contained possible codes to the text segments that were relevant to the RQs. Maxwell (2013) stated that coding in qualitative research is vital to categorize aspects of the phenomenon. In the coding spreadsheet, I arranged codes into meaningful segments and divided those segments into positive or negative perceptions in computer science courses. I used codes such as CS-POS for positive responses, CS-NEG for negative responses, and CS-NEU for neutral responses. I identified key phrases and statements about the phenomenon and looked for reoccurring patterns or similarities.

The third spreadsheet contained theme building. Creating this spreadsheet allowed me to get a better understanding of the responses relevant to the RQs. I was able to review the themes and compare them with the review of literature, identifying common characteristics of the phenomenon studied. I looked for word repetition with Excel software, which generated word-frequency lists from the text. This process helped with data analysis and was an effective way to look for emerging themes. For example, one of the RQs was, “What are your perceptions of females employed in computer science careers?” Common words were identified using a word cloud in the NVivo software and included computer, science, role, models, women, mentors, gender, field, and significant.

After the data had been organized and transcribed, I began analysis and developed common themes. A coding process was used to organize the data by dividing it into segments. The segments were labeled with codes, examined for any overlap and redundancies, and organized into common themes (Creswell, 2012). Data were then sorted, organized, and compiled using Microsoft Excel software. A basic inductive analysis was used to analyze the collected data with Excel as the data management system. As interviews were conducted and transcribed, I logged all information into an Excel spreadsheet, which I used to conduct an analysis of the participants’ responses. By creating themes and categories in Excel, I grouped responses and identified key areas of the data to identify themes.

I used several steps to ensure the accuracy and credibility of the data collection. I acknowledged any personal biases that might have influenced the findings. I captured experiences from the perspectives of the research participants and kept records of the interviews to ensure interpretations of the data were consistent. I confirmed with the participants that the information reflected their views and experiences. Transcripts of the interviews were provided to each participant for review to ensure the accuracy and credibility of the preliminary findings. The participants affirmed that the information reflected their views and experiences.

Executive Summary

The findings of this study will be presented to the main stakeholders at NJCC. An executive summary will be provided to stakeholders at NJCC with the results and findings of the project study, which can be used at my own institution and others like it. It is anticipated that the project study will be used at professional development workshops at NJCC and other 2-year institutions in New Jersey and at professional workshops and conferences at the local, state, and national levels to increase the enrollment of female students in computer science programs.

Data Analysis Results

To understand the perceptions and lived experiences of female students in computer science classes, I collected data from open-ended, semistructured interviews. In the sections that follow, I will discuss my role as the researcher, the interview process, post data collection procedures, and the credibility of the study.

Role of the Researcher

I was responsible for recruiting participants who met the criteria for this study. I e-mailed colleagues in the computer science department at NJCC and asked them to circulate my participation letter to women in their computer science courses. Based on the responses to the letter, there were seven females willing to participate in the study. Prior to the study, I had not met any of the participants. I arranged to interview the participants on the NJCC campus in a private conference room. As the researcher, I remained neutral throughout the interviews and did not interject any personal bias in this process. During data collection, I focused on the questions and asked the participants to elaborate on some of their responses to obtain sufficient data for my study. To avoid any researcher bias, I took extra precaution to focus only on the RQs.

Interviews

The most common approach to qualitative data collection is interviewing (Merriam, 2009). I chose to conduct interviews because I wanted to obtain female participants' perceptions and lived experiences, which fit a phenomenological approach; this type of study allowed me to tell the stories of my participants by sharing their experiences through interviews. The choice to use semistructured interviews precipitated the design and content of the interview questions in this study. The semistructured interview allows a researcher to ask prearranged questions while giving the participants the opportunity to answer the set of questions during the interviews. It is important to use preset questions during interviews to allow all participants to provide data to answer the RQs (Lodico et al., 2010). My interview questions were based on the four RQs from my study along with a subset of questions.

I conducted interviews with the seven participants, which ranged from 30 minutes to 1 hour. I used a random number generator to assign numbers to each participant to ensure confidentiality. The interviews were conducted on campus in a private conference room. I recorded the participants' responses using a digital device. After each interview concluded, I requested permission to contact the participant to conduct a member check to ensure the accuracy of my interview interpretations and findings. Each participant agreed to participate in the member check for validity. Member checking was used to determine the accuracy of the findings, and each participant was provided with a transcript of their interview for verification and accuracy of the data (Anney, 2014).

The consent forms, notes, and recordings were kept in a locked file cabinet in my home office to ensure participant confidentiality after each interview session. Once I completed all seven interviews, I purchased an audio transcription software, Temi. I initially planned to hire a professional to transcribe the interviews; however, I decided to use software that was cost-effective. I found the software to be 85%–90% accurate and was able to export the transcripts for each interview into a Word document, which I stored on a USB flash drive and kept in the locked file cabinet in my home office. These data collection procedures helped to secure the data and provide confidentiality for each participant.

Credibility

I used member checking to ensure the credibility of the data. Digital recordings ensured that I captured the participants' verbal expressions and thoughts throughout the interview process (Creswell, 2012). All participants were contacted via email; I provided them with electronic copies of their completed individual transcripts from their interviews. I asked each participant to verify their responses and to point out any discrepancies or provide feedback on the data and to confirm that their lived experiences were captured in the interviews. There were no discrepant or outlier responses in the data. Each participant verified that the transcripts reflected what was recorded during the interviews. The notes taken throughout the interview process supported the participants' responses and helped ensure the credibility of the data. The data collected provided rich, detailed descriptions of female students' perceptions and lived experiences in computer science courses.

Findings

Emerging themes were derived from the data collected that addressed the four RQs for this study.

Results for Research Question 1. The first RQ for this study was, "What are the perceptions of female students regarding their image of professionals in computer science fields?" This question had four subquestions, which were based on (a) the significant or insignificant of female role models and/or mentors for females in computer science, (b) whether gender diversity is portrayed in the classroom and in course materials, (c) whether gender impacts male and females' professional development in computer science, and (d) whether gender diversity is demonstrated in the computer science department. The primary themes that surfaced from the responses to this RQ and the subquestions included female mentors and role models in the computer science fields, overall gender diversity, and gender in professional development careers.

Theme 1: Female mentors and role models in computer science fields. The importance of female role models and mentors in computer science was significant to the participants. Some participants found that having a female role model was essential in their path to a computer science career. CS101 stated, “Female role models and mentors in this field are the concretization [*sic*] of what we female students are working toward to accomplish. They are living proof that we can make it in this field, just as they did before us.” CS103 added,

> I think it’s important for everyone of any gender to have strong role models, and it shouldn’t matter too much if the role model is female or not. That being said, I do recognize that there is still a gender divide in this country, and that some people need to see women stepping up into visible roles, whether it be in computer programming, computer network design, or even leadership of an IT team. I feel too that if more women stepped up into visible positions, it might create more impetus to choose females as role models.

CS107 explained,

> As I mentioned a bit before, I’d be hard-pressed to think of a famous female role model in computer science. Now, that may be due just to my own personal ignorance, but I do think the fact that I’ve had so many female professors has made a difference. Though it’s mostly subconscious, seeing women in those roles definitely made me feel more welcomed and able to fit in and like, “I could do this.” Though it sounds a bit harped on, representation does matter. And if I’d heard of more women pioneers in computer science, I might have come into the field much earlier and with more passion.

CS105 exclaimed,

> Extremely significant! I have found female mentors [mainly professors at NJCC] to be invaluable to my experience here. It's so rare that I do see women who [*sic*] in the field that I always remember when I do see someone. For example, I remember watching a YouTube video almost a year ago where a woman talked about being a software engineer, and while she didn't say anything new that I would find memorable, just knowing she exists is oftentimes important for me.

Finally, CS106 stated,

> I feel that female role models in computer science are not as significant as the men are. I feel that they do great things and should be just as significant, but the lack of females in the field makes it much harder to be a significant role model in a male-dominated field.

However, some participants gave neutral responses regarding the significance of having female role models or mentors for women in computer science. CS102 stated, "I feel like they can be important for other people. For me, I pay no mind what gender mentors or role models are. For other students, I think gender can play a role for their comfort in computer science." CS104 also noted, "I think a role model or mentor would be helpful, but not necessary, personally. I think that would be dependent on the person."

Having a role model in computer science, primarily a female role model, provides women with a sense of connection that can help mediate their careers in this field (Stout, Dasgupta, Hunsinger, & McManus, 2011). The sense of inclusion and having at least one supportive female role model are important factors in female students' decisions in pursuing their degrees in computer science (Ruiz, 2017). Findings from these studies supports the works of Stout and Camp (2014), emphasizing the importance of female students seeing successful role models who look like them.

Theme 2: Overall gender diversity. The lack of diversity in the classroom was expressed in the participants' responses. However, none of the participants found gender related distinctions in the course materials or textbooks. CS103 noted,

> If anything, my course materials have portrayed a more even gender split than my classes truly represent. In looking back through a variety of my textbooks, every time names are used as examples; there's an even split of typically male and typically female names. Similarly, book diagrams or photos feature men and women with equal frequency. In reality, my classes are very much male-dominated.

CS102 added, "Gender diversity is sort of lacking in [the] classroom but not lacking in course material. Course material is gender-neutral. However, gender diversity or the gender ration [*sic*] in classrooms are lacking as there are often more males than females." CS107 had the following to say about gender diversity in the classroom:

> As I mentioned, gender diversity in the classroom among students is borderline nonexistent. Or at least that's how it's been for me. The course material is pretty gender neutral and doesn't even come up that often, if at all. In math, you can have word problems where Sally gives apples to Rob and all these other little embedded opportunities for gender diversity, but I find that's been really rare in my CS classes. Hard to have gender diversity when the material calls for a loop that will increment an "*i*" value. The one thing I can think of that has shown good

> gender diversity is that in my GDEV 267 textbook the author will switch between gendered pronouns to describe the player or user when explaining how to make a game.

The participants responded to the question regarding gender diversity as practiced within the computer science department at the institution. Responses to this question were neutral, with most of the participants suggesting that the institution demonstrated gender diversity in this department. CS101 stated,

> I think that gender diversity is demonstrated even if the number of females involved is low compared to the number of men. For some reason, males prefer majoring in that field more than females do. I would appreciate [it] if there were more females in that field [professors and students].

CS105 added, “I think it’s great that the institution does have female professors in the computer science department, although I don’t believe true equality is reflected in either the staff or the students.” CS104 agreed with her peers: “Yes, I have had several female professors and the head of the department is a woman.” CS103 shared her thoughts on gender and the department:

> I feel that the computer science department is a little bit lopsided in favor of male teachers, but I personally view my instructors on the merit of their ability to communicate the information and topics of study. I don’t care as much what gender my instructor chooses to present; I care more that there’s an honest desire to be in the classroom, to want to teach, and to enjoy the topic being taught. That

> enthusiasm fuels my desire to learn and makes more of an impression on me than the presentation of gender.

Finally, CS106 added her thoughts:

> I actually feel that gender diversity is displayed in the computer science department, but I don't feel it is as much as other colleges or schools. We have a decent amount of female professors and people in the department, but I do feel that the people, or at least who I have come into contact within the department, the higher up people, are usually men. It could be based on who has been here longer or [who has] more experience, but I feel that women are usually put aside by companies for men who have the same or even less knowledge and experience. I do feel at this institution, however, that there is some gender diversity, but [the lack of gender diversity is] not as bad as other schools or companies.

Theme 3: Gender in professional development careers. Finally, the participants felt strongly about how gender impacted professional development in computer science careers. A study conducted by Locke (2016), reported that women opt out of STEM leadership positions due to the existence of negative relationship between stereotype threats and sexism for women in STEM. Findings from this study supports these assumptions. CS105 stated,

> Yes. I think it can be harder for women to get promotions if the boss favors the guy [with whom] he can have his stereotypically traditionally male conversations with [about sports or cars or whatever]. In Emily Chang's book, *Brotopia: Breaking Up the Boys Club of Silicon Valley*, she talks about how if the boss and

> other guys at work are hanging out outside of work playing something like golf, they will inevitably talk about work, and it can be hard for a woman to insert herself in those situations. Emily Chang gives a lot more extreme examples as well, but [that] one, in and of itself, is very telling.

CS104 noted, “I think that gender does impact professional development in the sense of internships and/or employment and training. That would fall on employers, though. In a male-dominated field, men would most likely do the hiring, so that is where the bias would fall.” CS103 elaborated,

> I think gender absolutely can impact professional development for male and female students, especially when it comes to gender identity and gender expectations. Not everyone is fortunate enough to be raised in an environment in which he or she is encouraged to do what he wants to do and to pursue those interests with support and enthusiasm. I feel that females can shy away from the technical fields, including computer science because they aren’t supposed to enjoy those fields. On the flip side of that, men can be criticized for pursuing the arts, for example, because that field of study is too girly.

Finally, CS106 expressed,

> I do feel that gender impacts male [*sic*] and females’ professional development in computer science. I feel that males are usually able to go farther and do more in their careers than females normally are. I’m not sure if it’s that the lack of women makes people believe they aren’t as competent as the men are, or if it’s just [that] the lack of women in the field makes it harder for women to get to the same high

levels as men, but it definitely does impact their professional development in many ways.

The participants found that role models are essential to the success of female students pursuing careers in computer science fields, and having more inspirational female figures in computer science could significantly increase the number of female students. Findings in some studies have concluded that role models and other support systems are needed to stop the decline of females in STEM careers and help increase the next generation of females in professional development careers (Meier, Niessen-Ruenzi, & Ruenzi, 2017; Van Camp, Gilbert, & O'Brien, 2019). These changes can help address barriers that females face in STEM and help advance women in STEM careers (Galván, 2020).

Results for Research Question 2. RQ 2 in this study asked, "What are the perceptions of female students on the content of computer science courses at NJCC in that they are found to be supportive or not supportive of their continued participation in computer science courses?" The participants responded to the question similarly, finding that all courses at NJCC were very supportive of their studies. All the participants also found that the courses were gender-neutral and that there were no issues of gender in their computer science courses. The only common theme to emerge from the data collected regarding this question was *gender-neutral*. Previous studies suggested that more research be conducted on curriculum and instructional practices of computer science courses in higher education (Singh, Allen, Scheckler, & Darlington, 2007). However, based on the responses of the female students in computer science in this study, curriculum, instructional practices, and computer science textbooks are gender-neutral and not geared toward male-specific or female content. CS101 stated,

So far, I haven't encountered any issues that is gender related in the course content. I feel those kinds of issues were more common years ago when females first got interested in computer science. Now, I feel like more women have entered that field, and society is trying to adjust course content so that it is fair to everyone involved.

CS107 added, "The content itself is fine, I think it's more the field's perception and stereotypical societal gender roles that causes the gender disparity."

Participants found that course content in computer science was gender neutral. However, the lack of preparedness in computer science courses is one of the primary reasons females did not pursue computer science majors (Lawler & Molluzzo, 2016). Prior lack of experiences can influence female's decisions not to pursue a computer science degree (Denner et al., 2014).

Results for Research Question 3. RQ 3 in this study was, "What computer science classes do female students find attractive that could lead them towards a career in computer science and their reasons for perceiving these courses from that perspective?" Some participants found programming courses and working with the various programming languages interesting because they are the basic foundation courses in computer science. Other participants found that web development and video game courses were attractive for women, leading them toward a career in computer science. CS105 explained,

> I think courses such as web development are attractive toward [*sic*] women because it [*sic*]can be creative, and, in this day and age, so many people have their own websites. Again, I think any of these courses could be attractive to more women if they were framed as something accessible and interesting to women. I think video games faced a similar stigma for a long time and still do [in] that they are made primarily for men, but in 2019, so many women play them. But the difference is that men and women aren't playing the same video games, because, demographically, they tend to have different interests. For example, Animal Crossing is a really popular video game among women that has only grown and maintained its popularity. I think if the assignments where we apply what we learn in our courses were made to be a bit more relevant to people's interests, then it could attract more women.

In addition, there were three common themes that emerged from the subset of questions and included *intimidation and anxiety*, *gender bias*, and *completion of a computer science degree*. All of the participants were apprehensive when they initially were the only female students in their computer science course. However, once the students became comfortable in their learning environment, the feelings of intimidation subsided.

Theme 1: Intimidation and anxiety. The feeling of intimidation at being the only female in a male-dominated career choice can be overwhelming for some. All of the participants expressed emotions of intimidation or anxiety with their first experience of being the only woman in a computer science course. Gender bias in computer science classes at the institution was clearly noticeable to them. CS106 stated,

> I feel a little bit intimidated by the classroom full of men, which usually includes the professor as well. It makes me doubt myself in the choice I've made by majoring in computer programming, which is heavily male-dominated. I also feel proud in a way that I am pursuing the career that I want, and that I am doing the work that everyone else is doing when I am expected to not do as well.

CS101 added,

> This happened to me this semester. I have noticed right away that I was the only female student in the Systems Analysis and Design class, and, at first, it freaked me out. I was uncomfortable at the beginning of the semester. Now, I'm just trying to focus on the class instead of that one aspect.

CS107 shared, "Usually, my initial thought is, 'Oh man, that sucks,' in the sense that more women would be better, but I don't feel alienated or anything like that." CS103 provided her observations:

> When I notice that I am the only female in the classroom, I force myself to be okay with it. I have just as much right to be there as anyone else, and when I take a class, it is with my expectation that I will put 100% effort into it. It honestly is nerve-wrecking at times, but I have found that one of my best coping skills is my slightly obsessive organizational mindset. Creating and using a planner to track course syllabi and assignments helps me focus more on the fact that I am there to learn and less on the gender split of the classroom.

CS105 shared her experiences:

> I used to feel very uncomfortable with it. I remember my first semester; I did not talk to anyone in my Java class because of it and did not know how to ask for help when I needed it. But I think this has forced me to grow out of my comfort zone, and so now I make myself more talkative with the people around me. I used to think that everyone around me knew so much more than I did and was very intimidated by it, but I no longer feel that way. I know that everyone around me is learning just like I am, and so I'm comfortable being at my own pace. It's taken a lot of time to teach myself not to feel inadequate, though.

Researchers have found that female students have high levels of anxiety in computer science courses (Ott, Bettin, & Ureel, 2018; Blaney & Stout, 2017). Isolation of female students has led to a marginal decrease in female enrollment in these courses. The importance of having social interactions and contacts with others are essential to the success of female students in computer science courses (Blaney & Stout, 2017; Leaper, 2015; Höhne & Zander, 2019).

Theme 2: Gender bias. The second theme was gender bias. Six of the seven participants did not experience any gender bias in their courses. Although this theme is an outlier, one of the participants did experience this, and it was important to document the experience of one participant in this study. CS103 described her experiences in the classroom:

> I have absolutely, and unfortunately, experienced gender biases. Sometimes I feel that it is difficult to be a female in computer classes. In all of my classes, I am in

> the minority in terms of gender identity. In one programming class, in particular, I am the only female in the classroom; the most females in any of my classes is five. There is some pressure in being a "girl" or the "token girl" in the classroom, and most of it comes from the other students. If I get good grades, it's not because I've studied hard, it's "because you work in the industry [networking class]" or "because the professor likes you [programming class]." If I have a question and raise my hand to ask in class, it's not because I need clarification on a lecture point or wish to answer a question the professor has asked the class; it's "because you're a teacher's pet." If I sit in the front row, it's not because I'm nearsighted and want to reduce eyestrain in looking at the board, it's "because you want to suck up."

Although gender biases can deter female students from continuing their studies in computer science, it is important for female students to practice self-efficacy. The absence of self-efficacy in female students is primarily due to them perceiving themselves as lacking the necessary skills in computer science (Main & Schimpf, 2017). Self-efficacy can increase self-confidence in female students' abilities to succeed, giving them the psychological motivation when faced with gender biases (Levinzon, 2018). CS103 went on to say how she demonstrated these skills,

> During lab work where I have finished my assignment [and I] am using my time to work on something else for the class, I have had questions directed my way that have been less, "How did you do this?" or "Can you give me a hint?" and more of the "Tell me exactly what you did?" or "Do it for me" variety. Replying to those

> questions with a negative—because there is no merit in copying my work [and] you do not learn anything from copying—has resulted in some form of insult aimed my direction from the asker.

CS103 further stated,

> The classroom environment for female students in computer science can be difficult since they are typically in the minority in every class (Wagner, 2016). Classroom environment and interactions are key factors to the success of female students. According to Lawler and Molluzzo (2016), interactions that occur with peers and faculty in the classroom can have an impact on whether or not female students want to remain in computer science majors. Even interactions with other female students in the classroom is challenging.

CS103 further stated,

> I have had male students scoff because I try to be friendly and interact with my professors; there have been implications made that I'm trying to suck up for a grade. I have had a female student who missed several lectures sit next to me because "us girls have to stick together" and promptly ask to copy the work I did in those classes she missed. It was not asking for the assignment numbers so she could do them on her own. It was [a] straight-up desire to get my file submissions and put her name on them all wrapped up in a "women-stick-together" package. I ultimately end up doing a lot of forcible ignoring of comments and trying not to let it show how hurtful they are or how stressed they make me feel.

CS103 concluded,

The support of computer science faculty can be a key influencer in female students' achievements in the program. The participant reported that professors in the computer science program have been supportive, offering their time to help her during their office hours. In addition to faculty support, the participant further suggested that individuals are responsible for their own accountability in the program. CS103 concluded,

> I do not feel the same pressures from my professors. I am a student who recognizes that I am paying for my education, and therefore I want to get the most out of it possible. I try to take full advantage of my time in the classroom with the professor, and I make use of my professors' office hours outside of the classroom and their willingness to answer questions via email. Said professors have always been willing to work with me and to provide valuable feedback, and I have never felt that I've received preferential or detrimental attention based on my gender.

Gender biases towards female students are too often displayed in computer science classes. The biases in which female students experience in the classroom can have a negative impact on their view of computer science. Female students can overcome these barriers through self-confidence and their abilities to succeed in the classroom. However, subtle and overt biases may follow females as they enter their careers in computer science. Although some females reported initial biases in the workplace, those biases were reduced once they proved themselves knowledgeable in the field and established working relationships with their peers (White, 2014). Females who remain in computer science careers overcame these biases through self-efficacy and a supportive environment.

Theme 3: Completion of a computer science degree. All of the participants responded that they planned to continue at NJCC toward the completion of a computer science degree. CS105 exclaimed, “Yes! I am graduating with my associate’s degree this December and have already been accepted into a few 4-year schools for next spring.” CS101 agreed, “Yes, I will continue in computer science. The more I learn, the more I want to keep going.” CS102 stated, “I am planning to continue towards the completion of a computer science degree and return [to school] to complete my bachelor’s.”

Results for Research Question 4. RQ 4 for this study was, “In what ways does the content of computer science classes change female students’ views towards the completion of a computer science degree?” The participants had overcome several obstacles as computer science majors, but completion of a degree in this field was more important than any obstacles they encountered. Common themes that emerged from data for this question were *challenging*, *interesting*, and *practical skills useful for careers in computer science*. CS102 noted, “The content of computer science classes helps me improve and pushes me more to complete the degree because I find it challenging and enjoyable all the same.” CS103 explained,

> For me, the content of a course has to interest me. Some of that is the content itself, and some of it is how the instructor presents said content. I feel that there is enough flexibility within the computer science department that I can somewhat customize my course selections, at least as far as electives go, and that means I

> can choose a path of study that interests me. I have also found my professors to be an excellent source of information about courses and course content. I have contacted several professors prior to registering for classes in order to talk about the contents of those classes; that has aided my decisions for what courses to pursue and what courses to let go [of]. I am honestly excited about my field of study, and I really do look forward to my classes and the chance to learn new things every day.

CS107 added, “If anything, it makes me more eager just because I love the subject so much. I’m constantly having my mind blown by the new things I learn. CS105 noted,

> I think since I’ve started, everything seems a lot less intimidating to me. Before I changed my major, computer science was my big amorphous Goliath that I was sure would be impossible for me to reckon with. However, I’ve found that a lot of what I’ve learned is practical and are skills that need to be honed rather than something that comes intuitively. If anything, I feel more independent because of this major and what it taught me because I know so much of my ability to succeed lies within how much effort I put forth.

Although the female participants faced several challenges throughout their time at NJCC in some of their computer science courses, they all were determined to succeed in in their computer science programs and further pursue computer science careers within their field of study. The participants’ determination to succeed was exemplified throughout their interviews. In fact, the participants felt that the obstacles they encountered gave them the drive and determination to overcome these barriers and to look at the positive aspects of what computer science will have to offer them in the future.

Summary

The results of this study included 10 themes that emerged from the participants' responses to the interview questions. Analysis of the data demonstrated the overlapping of these themes: (a) mentors and role models, (b) lack of gender diversity, (c) intimidation, and (d) the determination to succeed. The findings were consistent with studies from other researchers. The interpretation of my findings regarding the perceptions and lived experiences of female students in a computer science program are fourfold.

First, consistent with reports from other authors (Buzbee, 2017; Coleman, 2018; Krishnan, 2018; Michell, Szorenyi, Falkner, & Szabo, 2017), female role models and mentors contributed to the success of female students in computer science majors. Second, the lack of gender diversity is reported in many studies (Barr, 2017; Cheryan, Ziegler, Montoya, & Jiang, 2017; Diaz, 2018; Ehrlinger et al., 2018; Jung, Clark, Patterson, & Pence, 2017; Mone, 2017; Sax et al., 2017). The lack of gender diversity is prevalent at the NJCC, and the probable cause lies in the absence of support for female students in computer science programs. Third, intimidation of female students in computer science existed at the institution, although some reports concluded otherwise. Researchers have indicated that female students are less likely to become anxious or intimidated when other females are in the classroom (Hamberg, 2017; McRae, 2018). Having more female students in computer science courses or extracurricular activities and collaboration increased the rate of female student’s retention in computer science programs (McRae, 2018). Finally, the determination to succeed despite these obstacles was the driving force for the female participants to continue their education and obtain a degree in their computer science program. The support of female computer science faculty can help alleviate these obstacles (Hoffman & Friedman, 2018; Malik & Al-Emran, 2018).

The findings from this study indicate that there is a need for a formal mentor program for females in a computer science program at NJCC. Faculty, especially full-time female computer science faculty, need to be involved in the mentor program to improve female enrollment and retention in computer science programs. Section 3 includes a description and rationale of the formal mentor program.

Section 3: The Project

I concentrated on a policy recommendation of a formal mentor program to be implemented by stakeholders in the math and computer science department at NJCC for the success of female students in computer science programs. The problem addressed in this project is the underrepresentation of female students in the computer science program at a community college in central New Jersey. The purpose was to gain an understanding of the perceptions and lived experiences of female students enrolled in computer science classes at NJCC regarding computer science as an area of study as well as future employment in this profession. The seven participants in the study described their experiences in their computer science classes. Social constructivism theory provided the conceptual framework for this study in which each participant discussed their experiences, allowing me, the researcher, to view the world through their eyes (Lodico et al., 2010). This section includes the rationale of the project genre, a review of literature relating to the needs and success of mentors and role models for females in computer science, the project description, the project evaluation plan, and the project implications.

Rationale

The rationale for the project genre addresses the need for the implementation of a formal mentor program based on the perceptions and lived experiences of female students in computer science programs at NJCC. The project I recommend has the potential to affect social change in the Math and Computer Science department at NJCC. The formal mentor program will be established for female students enrolled in computer science programs at NJCC. Based on the analysis of the data collected in this study, 80% of the participants indicated that having a female role model at the institution would be helpful to their success in their computer science courses. The project recommendation will help provide a positive solution to address the problem of underrepresentation of female students in computer science programs at NJCC as indicated in the analysis of the data from this study.

Recent research has indicated that mentorship programs in higher education and career development increase the success of individuals in their career fields. Research has shown that female mentors protected females in engineering on the basis of self-efficacy, motivation, retention, and post-college aspirations (Dennehy & Dasgupta, 2017). Mentorship programs and experiences have had positive impacts on female students (Dennehy & Dasgupta, 2017; Perez, 2019). The project genre addresses the findings of study reported by the seven female participants. The formal mentor program at NJCC will be student-focused, and the collaborative efforts between mentors and mentees may have a positive impact not only on the culture at NJCC but the climate within the math and computer science department.

Review of Literature

The overall purpose of this literature review is to illustrate how the policy recommendation of a formal mentor program can be implemented at NJCC. Evidence from literature and the research were compiled to demonstrate the correlation between female students' success and faculty mentoring programs in computer science discipline and other related STEM programs. I compiled evidence from the literature that illustrates various mentor programs and the success attributed to these programs. I presented parallels between female student success in STEM programs and the implementation of faculty mentors at other higher education institutions. The literature and research support the challenges female students encountered in computer science classes at NJCC.

Mentor Programs

History of mentoring. The term *mentor* is derived from the individual, Mentor, in Greek mythology (Gotian, 2016). As Odysseus went off to war, Mentor was responsible for shaping Telemachos's life, assisting with his education, character, and decisions for over 20 years (Barondess, 1995). Mentor fulfilled the role of guiding Telemachus throughout childhood as he matured into adulthood. Today, mentors are often referred to as advisors, student advocates, coaches, or other terms to identify those who help guide students or even peers in their academic success or careers. Mentoring in academia traditionally refer to "advising," but there is a difference between mentors and advisors. Advising is part of a faculty's job responsibilities, whereas mentoring is a personal commitment for the well-being of another individual (Geary, 2019). Mentors, whether formal or informal in practice, are commonly a part of successful programs used in both corporations and academia (Birkeland, Davies, & Heard, 2019).

Definition of a mentor. There are various definitions of what it means to be a mentor, depending on the researcher. According to Campbell and Campbell (1997), a mentor is defined as a more experienced member in the workplace providing support, information, and guidance to a less experienced member in an organization. Laminack (2017) described a mentor as someone with wisdom and experience, who is available to help guide a person's pathway to success. Mentors can exist in corporations and educational environments. Protégés are defined as individuals who are tutored by mentors, and this term is often used in corporate practice.

Mentors can have both formal and informal relationships with their mentees. Informal mentors are often found in corporations where new employees seek guidance and advice from successful, more experienced employees. Mentors provide guidance and advice to mentees and facilitate the professional development of the mentee (Cleaver & Fincheme, 2017). For example, the former CEO of Apple, Steve Jobs, mentored Mark Zuckerberg, and billionaire Warren Buffett mentored Microsoft founder, Bill Gates (Cleaver & Fincheme, 2017). Recently, top female executives at STEM workshops and conferences have mentored females in these careers. The Grace Hopper Celebration of Women in Computing conference, Women in Cybersecurity conference, and the Computing Research Association—Women workshops are all aimed at increasing the success of females in computing careers (Hallman, 2018).

In academia, faculty primarily take on the role of mentor with students the mentees. Mentoring in academia refers to the developmental relationship between the mentor and the mentee. The mentor's primary responsibility is to support the professional development and socialization of the mentee (Reynolds & Parrish, 2018). These responsibilities are applied to both academia and corporate mentorship.

Purpose of a mentor program. Students who attend community colleges are less likely to earn a bachelor's degree than students who attend traditional 4-year colleges (Monaghan & Attewell, 2015). Students enrolled in community colleges are academically underprepared and do not enter school with a declared major as opposed to 4-year college students (Cohen, Brawer, & Kisker, 2014). Additionally, students in community college STEM programs are less likely to earn a bachelor's degree compared to 4-year college students (Wang, 2016). However, female students are more likely to succeed in community colleges than male students when support mechanisms are available (Juszkiewicz, 2015).

Female students often face negative stereotypes about their ability to succeed in computer science. One of the reasons females choose not to pursue computer science disciplines is because they do not feel a sense of belonging (Barker, Cohoon, & Thompson, 2010). A lack of gender diversity in the computing technology field creates this perception and is one of the driving forces behind female students' psychological need to fit into their environment (Barker et al., 2010). But researchers have found that most female students excel in STEM courses when they are connected to their environment and are therefore more likely to graduate in STEM programs (Ong et al., 2011). This type of environment is defined as inclusive, where female students' peers accept them unconditionally. However, an unreceptive environment based on gender, race, or sexual characteristics, can have a negative effect on female students' academic performance and persistence in STEM programs (Fisher et al., 2019). The sense of belonging and being part of a community within a program is vital for the success of these students (Rincón & George-Jackson, 2016; Thoman, Arizaga, Smith, Story, & Soncuya, 2014). For instance, students who interacted with their faculty obtained higher levels of achieving self-challenges and sense of belongings than students who did not interact with faculty (Kim & Lundberg, 2016).

Female students are more apt to switch majors if they do not feel they belong in computer science courses. Classroom experiences for female students play a major role in determining their continuation in computer science programs (Barker, O'Neill, & Kazim, 2014). A woman's sense of belonging is greater in the classroom when gender is equally represented than in a course with fewer women than men (Ehrlinger et al., 2018). If female students feel isolated or treated in a stereotypical manner, they will be less likely to continue in the computer science field. In addition, the way professors interact with female students in their courses can have a profound effect on if they continue in their program. STEM educators should strive to create an inclusive environment for all students in STEM programs (Lewis et al., 2017). Therefore, having a formal mentor program for female students is important to their future and their careers in computer science fields.

Research has demonstrated that mentor programs are essential in the development and success of female students in community colleges majoring in STEM programs. Findings from a study by Hu and Ortagus (2019) indicated that community colleges helped female students excel in STEM programs because they provided a suitable environment in which they could thrive. Palmer (2017) also noted that it is imperative for females to have role models or a support system in college to be competitive in the technology market in the future. Brunini (2017) found that female engineering students who had female mentors throughout their STEM programs stayed in their engineering courses and were successful as opposed to female students without mentors.

In addressing the importance of mentorship for female students, it is important to note that there is a distinct difference between faculty academic advising and faculty mentoring (Birkeland, Davies, & Heard, 2019). Academic advising consists of faculty assisting students with registration; their primary function is retaining and attracting students to their programs, whereas faculty mentoring includes assisting students in these areas as well as being informal mentors to students to provide advice and guidance. Students are more likely to reach out to professors with whom they interact in the classroom or through advising regarding their careers, research, or other important factors (Birkeland et al., 2019). However, higher achievement levels and increased retention has been seen regarding students with formal mentors (Campbell & Campbell, 1997). These formal mentor programs are still prevalent at many higher educational institutions today. Most of students' academic success may be based on the guidance and advice from their faculty mentors (LeMire, 2015). Additionally, female participants in a study conducted by Morata (2017) indicated that their mentors helped shape their character, build their confidence, and provided them with the support needed to achieve academic success. All these findings support the need for the implementation of a formal mentor program at NJCC.

Creating a formal mentor program. The retention of women in computer science is imperative to the program. Retention efforts also include female faculty in the computer science department. According to Wilker (2017), female faculty in STEM programs play an important role in recruiting female students in these fields. Research has also indicated that mentoring support from female faculty members is important for female students in STEM programs (Blake-Beard, Bayne, Crosby, & Muller, 2011;

Lockwood, 2006). Faculty are key factors in the success of female students in nontraditional careers such as computer science (Wilker, 2017).

Studies have indicated that computer science departments need to be supportive of women majoring in computer science and in computer science courses (Sax et al., 2018). Improving a female's sense of belonging and comfort in computer science has led to stronger academic achievement (Clinkenbeard, 2017). It is important for college computer science departments in colleges and universities to ensure that female students receive the support needed while fostering an environment leading to a sense of belonging, thus inspiring female students to achieve success. The recommendation of a formal mentor program will need full-time faculty involvement as well as involvement of students and other stakeholders in the computer science department at NJCC.

Faculty involvement. Researchers have suggested that the interactions with role models and advisors can influence the success of STEM students (Edwards, 2015; Jorstad et al., 2017). Woodson (2018) conducted a qualitative study on females' perceptions of faculty classroom practices and whether these practices influenced their decisions to persist in STEM majors. According to Woodson, positive classroom experiences and interactions with faculty are some of the reasons female students chose STEM programs in higher education. Based on the findings, Woodson recommended faculty develop effective teaching practices to promote positive faculty-student interactions in the classroom. Lehman, Sax, and Zimmerman (2017) also recommended that faculty should be involved in recruitment efforts focused on STEM disciplines, specifically in computer science and engineering due to gender gaps within these programs. A higher sense of self-efficacy for females in STEM majors has led to a determination in their disciplines (Aryee, 2017).

Studies have shown that a mentee's trust in their mentor is an important factor in establishing a relationship between faculty and student (McCown, 2018; Richmond, 2020). Chester and Mondello (2012) demonstrated evidence of the effectiveness in a faculty and student relationship through a formal mentor program. Chester and Mondello collected dataset from over 350 research studies on the effects of formal mentor programs versus informal mentors and found that mentees in formal mentor programs are more productive than mentees with informal mentors. A formal mentor program often involves a trustworthy relationship between both the mentor and mentee.

Faculty mentors should possess certain characteristics needed to assist students in their academic and career growth. According to DeAngelo, Mason, and Winters (2016), faculty who voluntarily mentor students beyond the classroom did so based on their past experiences as undergraduates. DeAngelo, et al.'s study revealed that faculty mentors are motivated by personal experiences and are excited to share those experiences with their mentees. DeAngelo et al. (2016) revealed that faculty mentors must possess both psychological and instrumental skills when working with their mentees Essential psychological characteristics for faculty mentors include being empathetic and possessing social skills, while instrumental skills give faculty the ability to guide and assist female students with academic studies and future career choices (DeAngelo et al., 2016). Empathy for female students encourages a sense of belonging and inclusion in a predominately male environment. Social skills help faculty create a better connection with their mentees while establishing a personal and informal relationship with them.

Finally, it is imperative for mentoring faculty to assist students with academic and future career choices. Hernandez, Estrada, Woodcock, and Schultz's (2016) concluded that mentors are socializing agents, assisting mentees with their career choices. The research discussed above focused on faculty involvement; however, female students' involvement is as essential as faculty mentors.

Female students' involvement. To ensure the success of the implementation of a formal mentor program, female students will also need to become actively involved in the program. It is imperative that the faculty mentor and the female student establish a successful relationship. Cleaver and Fincheme (2017) laid out five important guidelines for mentees to follow:

- Create realistic expectations and review them throughout the mentoring relationship.
- Create clear and concise responsibilities upfront between the mentor and mentees.
- Have a strategy or develop a strategy for the future to provide a focus on the mentoring process.
- Be proactive and provide plans to achieve and review throughout the mentoring process.
- Reflect upon goals throughout the process.
- Use imagination to explore future scenarios and decisions.

Other researchers provided guidelines and rules needed for establishing successful mentor-mentee relationships in academia (Martin, 2017; Masters & Kreeger, 2017). Martin (2017) reported qualities that a mentor should possess – good listener, facilitate thinking, knowledgeable in the field, self-reflective, cheerleader, provide feedback, available, and open to learning. Mentees need to have the following qualities – trust the mentor, self-reflective, good listener, good questioner, take responsibility, determine professional needs, take risks, admit failure, and is flexible and have time for the relationship (Martin, 2017).

Another important factor for female students to consider in a mentorship program is gender relationships. Female students in computer science programs must make a decision at the beginning of their studies, whether being in a mentoring relationship with someone of the same gender is important to the success of the mentoring process. Lockwood's (2006) study's findings indicated that female students were more likely to choose same gender role models because of gender-related obstacles in computer science courses and computer careers. A recent study by Kricorian, Seu, Lopez, Ureta, and Equils (2020) demonstrated the importance of mentorship programs for underrepresented students in STEM with faculty of the same gender or ethnicity. Questions arose as to whether male faculty could be as effective as female faculty in mentoring female students in computer science. Female participants in the study preferred female mentors; however, they were not adamant about having a male mentor (Kricorian et al., 2020).

Research conducted by Marx, Monroe, Cole, and Gilbert (2013) suggested that female role models in STEM are more effective at improving female students' outcomes than male role models. Studies have also noted that female students who identified with female professors improved their attitudes and performance overall (López Robledo, 2019; Young, Rudman, Buettner, & McLean, 2013). Leavey (2016) reported that women preferred female mentors to men. Women are also more apt to become involved in STEM careers when reading articles or biographies on successful female role models in STEM (Herrmann et al., 2016). However, it is important to note that most of the female faculty members in computer science at NJCC are not full-time tenure track professors, and the underrepresentation of tenured female faculty may result in the loss of female role models. The determination of whether faculty involvement should include female mentors will need to be addressed by stakeholders in the computer science and mathematics department.

Project Description

The goal of this project is to provide the major stakeholders with the findings of this report on the perception and lived experiences of female students in computer science courses. The stakeholders consist of the chairperson and faculty from the mathematics and computer science department. The formal mentor program offers a strategy to ensure female student success in computer science programs at NJCC. The outcomes could also improve the campus climate and help all stakeholders to assist female students' success at this campus.

The local problem is that there is an underrepresentation of female students in the computer science program at NJCC. A collaborative formal mentor program between female computer science faculty and female students at NJCC is needed to help with student academic success and to increase their enrollment in computer science programs.

The support and resources that are available for female students from computer science female faculty could influence their behavior and encourage them to succeed in computer science programs (Wang, 2013). Faculty mentorship services are needed in higher education to improve relationships between faculty, mentors, mentees, and peers (Mishra, 2020).

Support is needed from the computer science and mathematics chairperson and the full-time female faculty in the department to implement a formal mentor program. Implementation for the formal mentor program is key to its success. A timetable, schedule of meetings, and goals can be developed by the stakeholders. Establishing trust between mentors and mentees is the primary element for the success of this program at NJCC.

I will meet with the primary stakeholders and present the results of my study. My findings can be presented at a mathematics and computer science department meeting led by the chair of the department. I will use a PowerPoint presentation to reveal my findings and the recommendation of a formal mentor program for female students in computer science programs. I will allow time to the stakeholders for questions after my presentation and follow up with a hardcopy evaluation survey.

The advantage of presenting my findings and recommendations at the mathematics and computer science department meeting is to have all the primary stakeholders review my project study in the same setting and for them to be able to state their opinions regarding the project. Having the stakeholders available in one setting will also give them the opportunity to support or reject the project, offer additional suggestions, share their opinions, and determine whether they would want to move forward with the project's implementation.

I plan to present my findings to the stakeholders during the Fall 2021 semester. This will give the stakeholders time to review the findings and establish a formal mentor program, which will be implemented during the next academic school year. I will also make myself available to help with the implementation of the formal mentor program if the stakeholders need me to be involved in this effort.

My role and responsibility as a researcher are to present the results of my findings to the stakeholders of the mathematics and computer science department and recommend a solution to the local problem that there is a lack of women enrolled in computer science programs at NJCC. I will then discuss, in detail, my recommendation for a formal mentor program for the department and explain the importance of the project. After the presentation, I will take questions from the stakeholders to clarify anything that may have been misunderstood. The stakeholders, given this information, will be able to interpret my findings of the local problem and determine whether my recommendation is feasible to implement at NJCC. The stakeholders could also offer advice regarding the local problem along with their own solutions to the problem or reasons for supporting the project. After the question and answer session is over, I will provide the stakeholders with a hardcopy of an evaluation survey. This survey will determine whether this project was meaningful and relevant to them.

Project Evaluation Plan

The stakeholders (i.e., faculty in the math and computer science department) will interpret my findings and the presentation of the research. The stakeholders' evaluations of the project may lead to all parties coming together to collaborate on the recommendations of a formal mentor program. They could state their opinions about the project, reasons for supporting it, and offer their own recommendations or solutions. Stakeholders will be asked to evaluate the project by filling out a short five-question survey consisting of multiple-choice and open-ended responses or comments (see Appendix D). The survey will be given to the stakeholders to help determine whether the project is meaningful. Results from the survey will highlight the stakeholders' opinions pertaining to my findings and recommendations of the project. The results may convince the stakeholders to meet further to discuss future interests in the implementation of a formal mentor program.

The evaluation will help me to determine whether I should move forward and present my project findings to several computer science conferences where faculty in higher education present their proposals. Based on the outcome at NJCC, I plan to present my project to local community college workshops and conferences in New Jersey, including the Community College Computer Consortium. In addition, in the next 3 to 5 years, I plan to present at several conferences within the United States, such as the Lilly Conferences on College and University Teaching and Learning, the Grace Hopper Celebration of Women in Computing, the Association for Computing Machinery, and the National Center for Women and Information Technology.

Project Implications

This study highlighted the perceptions and lived experiences of female students in computer science courses at a midsized community college in central New Jersey. The findings indicated that female students need mentors and role models to assist with the success and completion of their computer science programs. Based on the overall findings of the study, a formal mentor program is proposed to ensure that female students will have the support and coaching needed for success in computer science programs at NJCC.

As female students continue with their studies in computer science courses, it is imperative that stakeholders from the computer and mathematics department become involved in reviewing the enrollment, retention, and graduation rates of these students in computer science programs. Based on the data in Table 1, it is important for these stakeholders to assist female students on their educational journey and work collaboratively to implement a successful formal mentor program.

This study reflects the need for faculty/student mentoring programs in higher education institutions as well as successful mentoring programs in computer science careers and industries. The current literature discussed in this study demonstrated the contributions and achievements of mentoring programs in STEM programs. Based on the findings of this study, female participants in the study in computer science courses at NJCC experienced isolation, gender disparity, intimidation and anxiety, and other negative factors without the support and guidance of role models during their college experiences in computer science programs.

The need to implement a formal mentor program at NJCC is essential to female students, not only in computer science but also in other STEM programs. To see positive change, the institution may need to analyze other programs at the school that have low female student enrollment. NJCC may also need to invest in more full-time female faculty in computer science. Full-time female faculty in this discipline are essential to enhancing academic advising and pedagogical practices as well as being contributors to the implementation of a formal mentoring program.

Section 4: Reflections and Conclusions

In this section, I discuss the project strengths and limitations, provide recommendations and alternative approaches, describe scholarship, explain the project development, and demonstrate leadership and change. I also reflect on the importance of the work and discuss the project study's implications and applications as well as directions for future research. As a professor in computer science at a community college, I am determined to assist in the implementation of a formal mentor program for female students. This study has provided me with the motivation to further investigate the need for a formal mentor program at my own institution to ensure the success of female students in computer science programs.

Project Strengths and Limitations

The project's strength is that it is a viable plan to get stakeholders from the mathematics and computer science department involved to collaborate and develop a formal mentor program for female students in computer science programs. The project that I will present focuses on the lived experiences of female students in computer science courses and their perceptions in these courses. The stakeholders will have the opportunity to meet and collaborate after my presentation to share ideas on how they can implement the formal mentor program based on the research study's findings. However, the project has several limitations that may impact the implementation of the formal mentor program. The first limitation is that the institution may not have a sufficient amount of full-time female faculty in the computer science department to implement the formal mentor program. Although human resources may be limited in full-time female faculty, NJCC can recruit female faculty from mathematics to mentor female students from the computer science discipline as both programs are in the same department and part of STEM education system at NJCC. The second limitation of this project is the impact on the timeframe of my presentation to the stakeholders and is due to environmental factors beyond my control. Due to COVID-19, NJCC is conducting classes and operations remotely, with all stakeholders providing services online. These uncertainties may affect the timing of my presentation; therefore, I may need to extend the date beyond the spring semester to fall of 2021.

Recommendations and Alternative Approaches

For this study, I used a qualitative methodology to obtain data. The phenomenological design was the best approach for me to gather data regarding the participants' perceptions and lived experiences. This type of study allows the participants to tell their stories by sharing their experiences and for me to present a description of these experiences (Creswell, 2012; Hatch, 2002). The data collected provided rich, detailed descriptions of female students' perceptions and lived experiences in computer science courses. An alternative approach to this type of study would have been quantitative methodology. A quantitative methodology is used for experiments, polls, questionnaires, and surveys. Quantitative surveys may capture a large amount of data; however, this would not allow female students to share their perceptions in computer science courses. Data obtained from a quantitative study would not provide the information necessary for me to identify common themes that led to the recommendation to improve the perceptions and lived experiences of female students in computer science programs at NJCC. Therefore, a qualitative approach was appropriate.

Scholarship, Project Development, and Leadership and Change

As a doctoral student of education at Walden University, I studied methodologies and research designs for conducting research studies. In reviewing both quantitative and qualitative methodologies, I decided to pursue a qualitative approach. After reviewing several different qualitative designs, I chose to conduct a phenomenological study as the best approach to gather data to answer my RQs. It was important for me to collect data on the lived experiences of my research participants and accurately reflect their responses. Scholarship for this study involved analyzing related peer-reviewed literature to understand the problem of low enrollment of women in computer science disciplines and reviewing the background materials of those sources. As a scholar, I was able to collect data and present accurate findings while maintaining the confidentiality of my participants.

After completing data collection and reporting the findings of the study, I determined a project to develop that was best suited to the study. I reviewed the four themes that emerged from the study several times to determine which theme was best suited to project development. In evaluating the themes, I was able to determine that a formal mentor program for female students in computer science programs would be beneficial to NJCC. A formal mentor program can address the four themes that emerged from the study: (a) mentors and role models, (b) lack of gender diversity, (c) intimidation, and (d) the determination to succeed. I will present the formal mentor project to the stakeholders at the computer science and mathematics department meeting where all stakeholders will attend. After presenting my findings and project recommendation as a PowerPoint presentation, I will hold a question and answer session and conclude by asking the stakeholders to complete a survey to evaluate the project.

As a program coordinator for the CIS program at a higher education institution, I have improved my leadership role throughout my doctoral journey. I understand the importance of increasing enrollment, retention, and graduation rates. I have been able to incorporate some of the mentoring tools I learned into my own program at the institution where I am currently employed. I provide informal mentoring to students, especially female students in my program. I am also working with local industries and local 4-year higher education institutions to establish internship programs for students at a 2-year institution to gain experience in the computer science field while taking courses and obtaining an associate degree.

In my project study, leadership consists of the stakeholders in the mathematics and computer science department. It is essential that these leaders understand the importance of a formal mentor program at NJCC to improve enrollment in STEM disciplines, particularly the computer science programs. Stakeholders understanding the perceptions and lived experiences of female students in computer science courses at NJCC can help address findings from the study.

Based on the findings of the study, it is imperative that changes in female student enrollment in computer science programs occur, not only NJCC but also at most colleges and universities. Within the last 5 years, colleges have tried to implement social change to increase female enrollment in STEM programs. By presenting this project study at my institution, at local colleges and universities, and conferences and workshops, there is the potential for social change through the implementation of mentoring programs by stakeholders. It is important that female students in computer science programs have mentors and female role models to eliminate gender disparity as these are essential in their pathway toward a computer science career.

Reflection on the Importance of the Work

As I reflect upon my journey as a doctoral student at Walden University and conducting research on the perceptions and lived experiences of female computer science students, I recalled my experiences as an undergraduate student in computer science at a 4-year institution. This research gave me the opportunity to understand the challenges female students are facing in computer science programs. As a computer science professor with over 12 years' experience, I was able to find a possible solution to the problem of low female enrollment in this field and help them overcome the challenges they face through the recommendation of a mentor program at NJCC.

I have strengthened my skills as a researcher through reviewing the relevant literature, analyzing and synthesizing the literature, and the data collected from my study, as well as developing critical thinking and writing skills. The skills I learned in my doctoral program helped me implement new curricula in my classrooms. As course coordinator for a general education technology course, students in these courses are now writing an APA format research paper on the latest IT topics. I am also assisting my students to develop their research skills. Students apply critical thinking and literature reviews into their research and are learning the importance of APA and citing information correctly.

Implications, Applications, and Directions for Future Research

The goal of this project study was to determine what solutions can be implemented to assist female students with their perceptions and lived experiences in computer science courses. In this project study, I recommend a policy for a formal mentor program to be collaboratively implemented by the stakeholders within the math and computer science department at NJCC. The development of a formal mentor program can help facilitate and improve female students' academic achievements in computer science programs. The findings of this study provide a better understanding of a widespread problem in higher education institutions across the nation. A challenge that confronts higher education, both nationally and locally, is that there is a disproportionate number of women compared to men who are not pursuing degrees in computer science. Data from this study highlighted the lived experiences of seven female students who are currently in computer science programs at NJCC to better understand their perceptions about their courses in this field. This study's findings and the project developed from these findings could improve female students' educational experiences and prepare them for career opportunities in the field.

Seven participants were interviewed for this study to understand their perceptions and lived experiences as female students in computer science courses. Findings from this study demonstrate a need for a formal mentor program for female students in computer science programs. The importance of stakeholders embracing a formal mentor project can have a greater influence on female students beyond their educational experiences. Future research can be conducted to assess the formal mentor program, determining whether it is successful for female students in computer science programs at NJCC. An evaluation plan could determine whether the formal mentor program is beneficial to those students through surveys and data analyses. Stakeholders at other institutions with similar challenges and gaps in enrollment could benefit from this study by reviewing the results of this project. A formal mentor project could be implemented at other institutions and address gender gaps in STEM programs to meet the specific needs of students at those institutions. This project can be used to create positive social change at other colleges or universities.

Conclusion

The purpose of this study was to gain an understanding of the perceptions and lived experiences of female students in computer science courses at a midsized community college in central New Jersey. A phenomenological research study was conducted with seven female participants in computer science courses at NJCC using one-on-one, semistructured interviews. Findings from this study indicate that female mentors and role models are essential to the success of the female student- participants who are pursuing careers in computer science fields at this institution.

I recommend a formal mentor program to be implemented by the stakeholders in the computer science and mathematics department. Female students in computer science will be assigned a mentor throughout their enrollment at NJCC. The chairperson and full-time faculty in computer science can develop collaborative strategies to implement a formal mentor program for female students in the program.

Initially, I began this study to understand why there was an underrepresentation of women in computer science. Based on the interviews from the seven female participants and the data analysis, female role models and mentors can be essential to the contributions and success of these female students majoring in computer science at NJCC. Female computer science faculty may help alleviate obstacles that these students encounter during their time at NJCC. The addition of support mechanisms and collaboration could increase female student retention in computer science programs.

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Appendix A: The Project

Improving Female Students' Perceptions and Lived Experiences in Computer Science Programs: A Collaborative Effort

Recommendation of A Formal Mentor Program by Terry M. Voldase

The goals of the presentation are to:

- Inform stakeholders in the computer science and math department about research findings of a study that identified female students' perceptions and lived experiences in computer science programs.
- Highlight a lack of female mentors/role models for female students' in computer science courses.
- Recommendation for stakeholders in computer science and math department to implement a formal mentor program to improve female students' success and achievements in computer science programs at NJCC.

Appendix B: Interview Questions

The following questions are designed to guide the interview. Since this is a semistructured interview, follow-up questions may be conducted to obtain more information based upon the interviewees' responses.

General Questions:

1. Can you tell me how you became interested in computer science?
2. What was the primary influence(s) that motivated you to major in computer science?
3. What are your perceptions of females employed in computer science careers?

What are the perceptions of female students on the content of computer science courses at NJCC in that they are found to be supportive or not supportive of their continued participation in computer science courses?

1. How would you describe the content in your computer science classes?
2. Are there issues of gender relations in computer science course content? Explain.
3. Is there any content in computer science classes that you perceive not to be gender neutral?
4. Is there anything(s) that you would like to see changed in the content?
5. Would content change attract more females?

What are the perceptions of female students regarding their image of professionals in computer science fields?

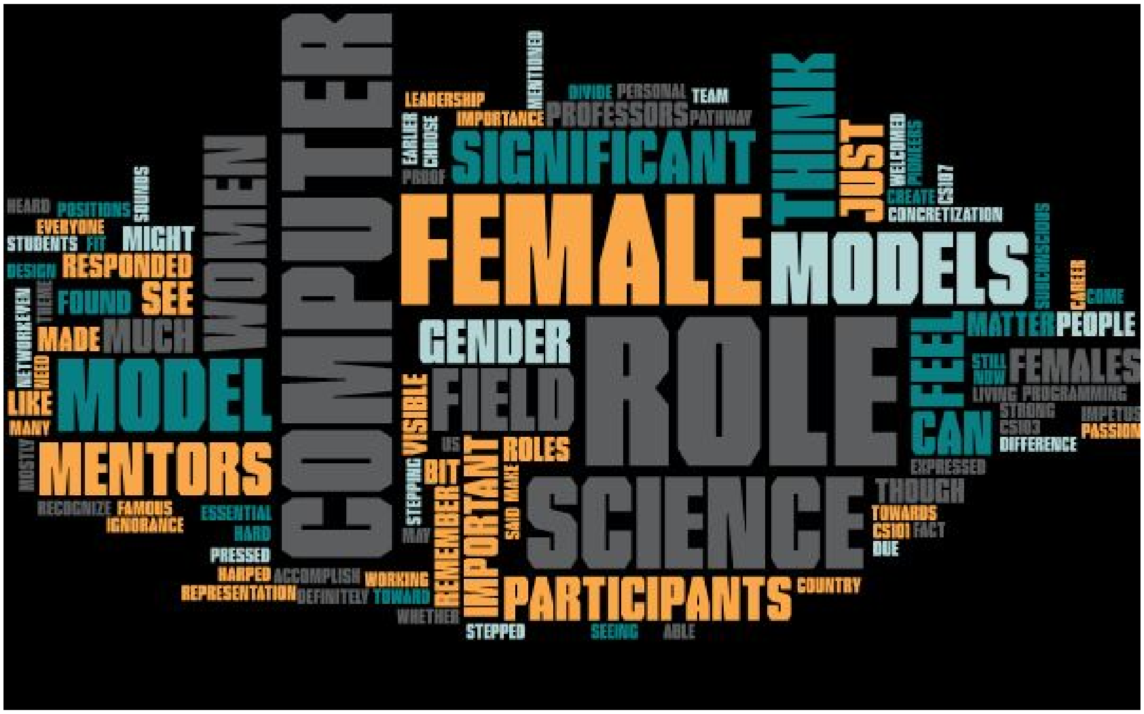
1. How significant/insignificant do you feel female role models and/or mentors for females in computer science are?
2. Do you feel that gender diversity is portrayed in the classroom and in course materials?
3. Do you feel that gender impacts male and females' professional development in computer science? Explain.
4. Do you think gender diversity is demonstrated in the computer science department? Explain.

What computer science classes do female students find attractive that could lead them towards a career in computer science and their reasons for perceiving these courses from that perspective?

1. How do you feel when you notice that you are the only female student in a computer science class?
2. Have you experienced any gender biases among your peers in your computer science course(s)? Explain.
3. Are you planning to continue towards the completion of a computer science degree?

In what ways does the content of computer science classes change female students' views towards the completion of a computer science degree?

Appendix C: Word Cloud



Appendix D: Project Evaluation Survey

1. The project presentation provided valuable research findings of female perceptions and their lived experiences in computer science programs.

    ___ Agree ___ Partially Agree

    ___ Disagree ___ Neither Agree or Disagree

    Comments: ____

2. The project presentation demonstrated how the recommendation of a formal mentor program could help support female student achievement in computer science programs.

    ___ Agree ___ Partially Agree

    ___ Disagree ___ Neither Agree or Disagree

    Comments: ____

3. The formal mentor program exemplified reasons for implementation and support from stakeholders in computer science.

    ___ Agree ___ Partially Agree

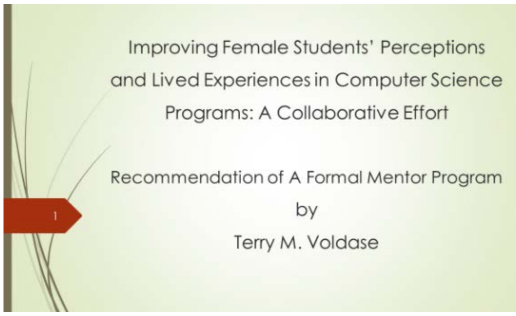
    ___ Disagree ___ Neither Agree or Disagree

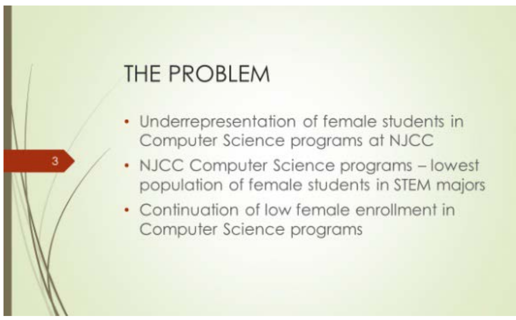
    Comments: ____

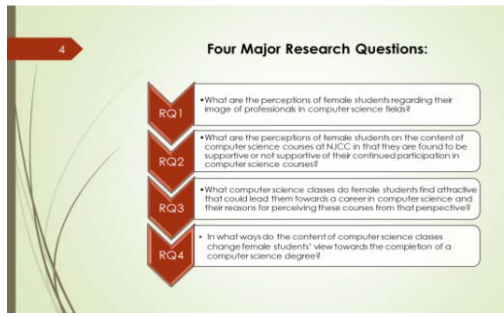
4. What is your overall perception of instituting a formal mentor program for female students in computer science?

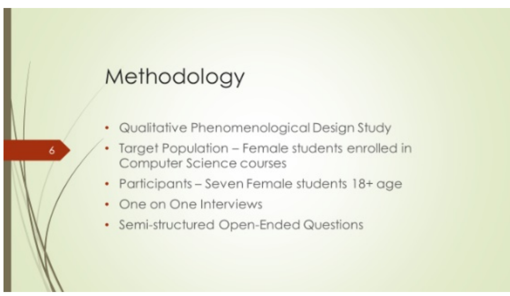
5. What is your overall perception of the project recommendation and research findings?

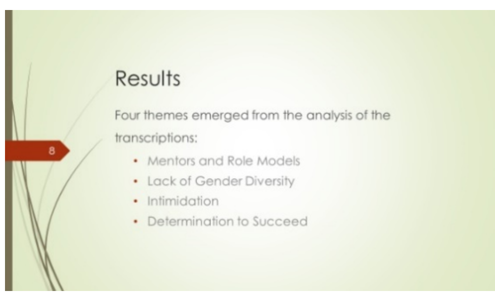
Appendix E: PowerPoint Presentation to Stakeholders

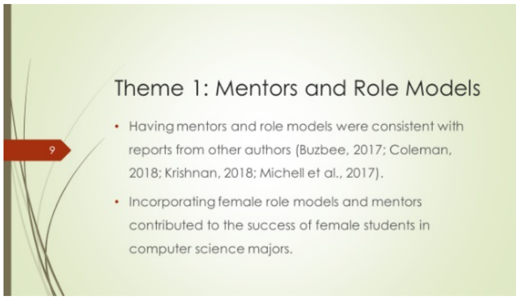








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Theme 1: Mentors and Role Models
Having mentors and role models were consistent with reports from other authors (Buzbee, 2017; Coleman, 2018; Krishnan, 2018; Michell et al., 2017).
Incorporating female role models and mentors contributed to the success of female students in computer science majors.


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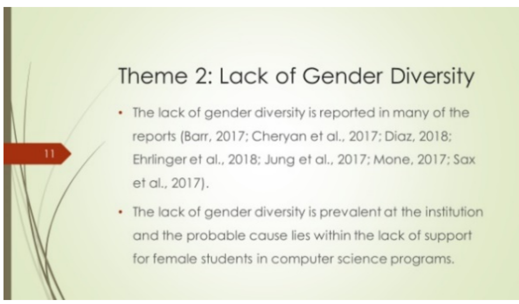
Several Interviewees gave similar responses on female role models and mentors:
"As I mentioned a bit before, I'd be hard pressed to think of a famous female role model in computer science. Now, that may be due just to my own personal ignorance, but I do think the fact that I've had so many female professors has made a difference. Though it's mostly subconscious, seeing women in those roles definitely made me feel more welcomed and able to fit in and like I could do this. Though it sounds a bit harped on, representation does matter. And if I'd heard of more women pioneers in computer science, I might have come into the field much earlier and with more passion"
"Female role models and mentors in this field are the concretization of what we female students are working toward to accomplish. They are living proof that we can make it in this field just as they did before us"
" I feel that female role models in computer science are not as significant as the men are. I feel that they do great things and should be just as significant but the lack of females in the field makes it much harder to be a significant role model in a male dominated field"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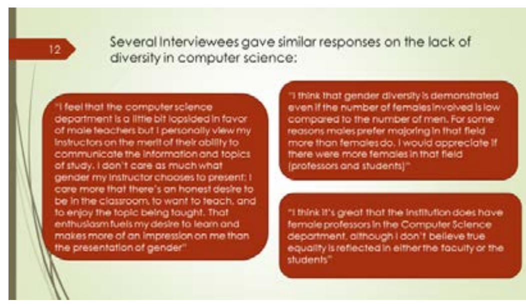
Theme 2: Lack of Gender Diversity
The lack of gender diversity is reported in many of the reports (Barr, 2017; Cheryan et al., 2017; Diaz, 2018; Ehrlinger et al., 2018; Jung et al., 2017; Mone, 2017; Sax et al., 2017).
The lack of gender diversity is prevalent at the institution and the probable cause lies within the lack of support for female students in computer science programs.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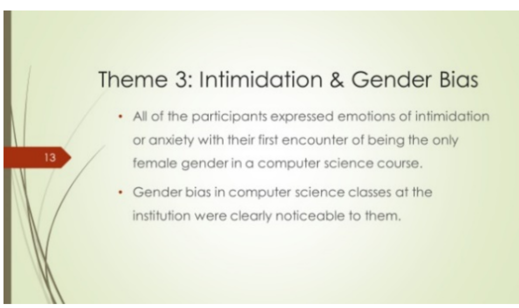
Several Interviewees gave similar responses on the lack of diversity in computer science:
"I feel that the computer science department is a little bit lopsided in favor of male teachers but I personally view my instructors on the merit of their ability to communicate the information and topics of study. I don't care as much what gender my instructor chooses to present; I care more that there's an honest desire to be in the classroom, to want to teach, and to enjoy the topic being taught. That enthusiasm fuels my desire to learn and makes more of an impression on me than the presentation of gender"
"I think that gender diversity is demonstrated even if the number of females involved is low compared to the number of men. For some reasons males prefer majoring in that field more than females do. I would appreciate if there were more females in that field (professors and students)"
"I think it's great that the institution does have female professors in the Computer Science department, although I don't believe true equality is reflected in either the faculty or the students"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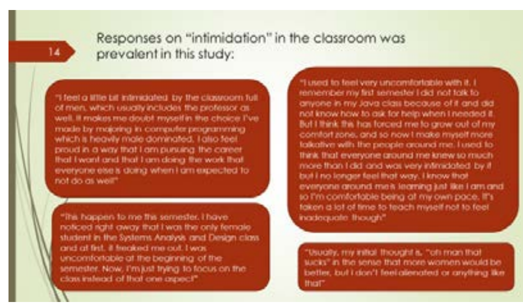
Theme 3: Intimidation & Gender Bias
All of the participants expressed emotions of intimidation or anxiety with their first encounter of being the only female gender in a computer science course.
Gender bias in computer science classes at the institution were clearly noticeable to them.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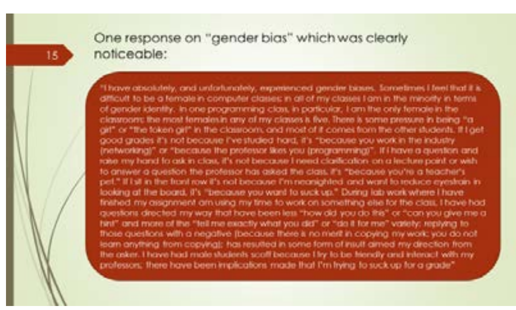
Responses on "intimidation" in the classroom was prevalent in this study:
"I feel a little bit intimidated by the classroom full of men, which usually includes the professor as well. It makes me doubt myself in the choice I've made by majoring in computer programming which is heavily male dominated. I also feel proud in a way that I am pursuing the career that I want and that I am doing the work that everyone else is doing when I am expected to not do as well"
"This happen to me this semester. I have noticed right away that I was the only female student in the Systems Analysis and Design class and at first, it freaked me out. I was uncomfortable at the beginning of the semester. Now, I'm just trying to focus on the class instead of that one aspect"
"I used to feel very uncomfortable with it. I remember my first semester I did not talk to anyone in my Java class because of it and did not know how to ask for help when I needed it. But I think this has forced me to grow out of my comfort zone, and so now I make myself more talkative with the people around me. I used to think that everyone around me knew so much more than I did and was very intimidated by it but I no longer feel that way. I know that everyone around me is learning just like I am and so I'm comfortable being at my own pace. It's taken a lot of time to teach myself not to feel inadequate though"
"Usually, my initial thought is, "oh man that sucks" in the sense that more women would be better, but I don't feel alienated or anything like that"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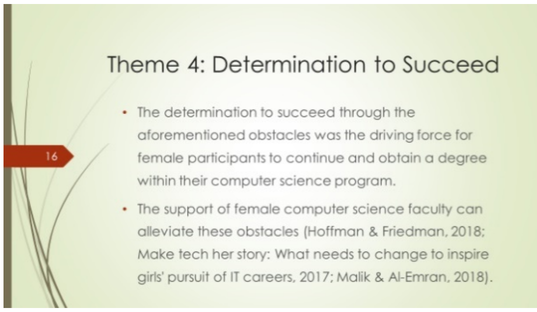
One response on "gender bias" which was clearly noticeable:
"I have absolutely, and unfortunately, experienced gender biases. Sometimes I feel that it is difficult to be a female in computer classes; in all of my classes I am in the minority in terms of gender identity. In one programming class, in particular, I am the only female in the classroom; the most females in any of my classes is five. There is some pressure in being "a girl" or "the token girl" in the classroom, and most of it comes from the other students. If I get good grades it's not because I've studied hard, it's "because you work in the industry (networking)" or "because the professor likes you (programming)". If I have a question and raise my hand to ask in class, it's not because I need clarification on a lecture point or wish to answer a question the professor has asked the class, it's "because you're a teacher's pet." If I sit in the front row it's not because I'm nearsighted and want to reduce eyestrain in looking at the board, it's "because you want to suck up." During lab work where I have finished my assignment am using my time to work on something else for the class, I have had questions directed my way that have been less "how did you do this" or "can you give me a hint" and more of the "tell me exactly what you did" or "do it for me" variety; replying to those questions with a negative (because there is no merit in copying my work; you do not learn anything from copying); has resulted in some form of insult aimed my direction from the asker. I have had male students scoff because I try to be friendly and interact with my professors; there have been implications made that I'm trying to suck up for a grade"


Theme 4: Determination to Succeed
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• The determination to succeed through the aforementioned obstacles was the driving force for female participants to continue and obtain a degree within their computer science program.
• The support of female computer science faculty can alleviate these obstacles (Hoffman & Friedman, 2018; Make tech her story: What needs to change to inspire girls' pursuit of IT careers, 2017; Malik & Al-Emran, 2018).


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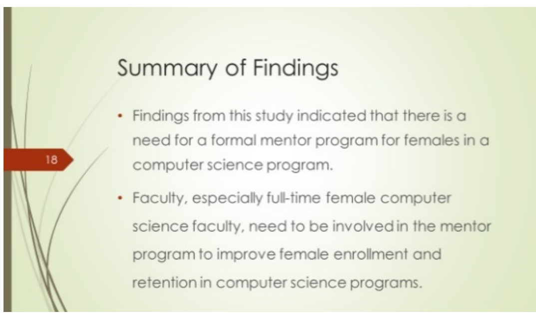
All Interviewees were determined to succeed in their computer science program:
"I think since I've started everything seems a lot less intimidating to me. Before I changed my major, Computer Science was my big amorphous Goliath that I was sure would be impossible for me to reckon with. However, I've found that a lot of what I've learned is practical and are skills that need to be honed rather than something that comes intuitively. If anything, I feel more independent because of this major and what it taught me, because I know so much of my ability to succeed lies within how much effort I put forth"
"The content of computer science classes helps me improve and pushes me more to complete the degree because I find it challenging and enjoyable all the same"
"If anything, it makes me more eager just because I love the subject so much, I'm constantly having my mind blown by the new things I learn"


Summary of Findings
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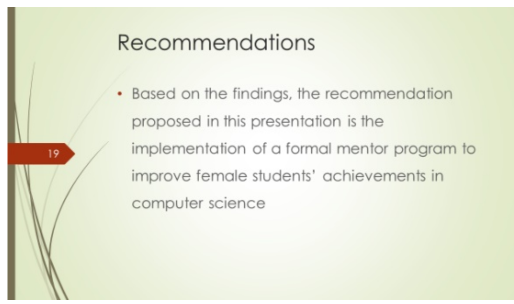
• Findings from this study indicated that there is a need for a formal mentor program for females in a computer science program.
• Faculty, especially full-time female computer science faculty, need to be involved in the mentor program to improve female enrollment and retention in computer science programs.


Recommendations
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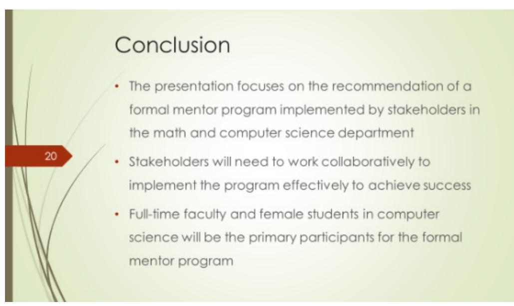
• Based on the findings, the recommendation proposed in this presentation is the implementation of a formal mentor program to improve female students' achievements in computer science


Conclusion
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• The presentation focuses on the recommendation of a formal mentor program implemented by stakeholders in the math and computer science department
• Stakeholders will need to work collaboratively to implement the program effectively to achieve success
• Full-time faculty and female students in computer science will be the primary participants for the formal mentor program